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ABSTRACT

This report summarizes and assesses the planning and first-year implementation of the Industrial Technology Program created through a partnership between South Shore Vocational Technical High School (SSVT) in Hanover, Massachusetts, and Procter & Gamble (P&G). It is a guide for the development of effective education/industry partnerships. An executive summary and introduction are followed by a description of the planning and development processes that created the program. The third section lists 68 competencies in 9 categories included in the joint industrial technology curriculum and discusses special program features. The fourth section assesses the curriculum and first-year outcomes as they relate to the expectations of P&G managers and machine operators, SSVT, labor officials, and other manufacturing firms. The fifth section reviews the demand for industrial technology programs in a vocational education setting. It considers occupational demand, management's perceptions regarding training needs and the role of vocational education, and career awareness programs to create demand for vocational/industrial technology education. The sixth section describes trends in vocational education and how partnerships fit in. A sample is provided of industrial partnership programs and articulation collaborations in Massachusetts. The report concludes with recommendations for SSVT, Massachusetts vocational-technical schools, and Massachusetts manufacturers. Appendixes include a list of interviewees, interview instruments, and a 42-item annotated reference list. (YLB)

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# A PARTNERSHIP APPROACH TO INDUSTRIAL TECHNOLOGY EDUCATION

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# A PARTNERSHIP APPROACH TO INDUSTRIAL TECHNOLOGY EDUCATION

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The research was carried out by John Hoops, Eleni Papadakis, and Ann Wheeler. Assisting in preparation of the report were Audni Miller-Beach, President, Workplace Learning, Inc., and Charles Colby, President, RWDSU, Local 444.

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# EXECUTIVE SUMMARY

## Overview

To maintain the health of Massachusetts' economy, particularly in the manufacturing sectors, we need a large body of technically trained and skilled workers to help the firms in which they work achieve world-class standards of quality and efficiency. The source for these workers is in our school systems, especially in our vocational and technical school systems.

Student enrollments, resource allocations, and the number of manufacturing-related educational programs in vocational education schools have declined, due—in part—to long-term shifts in industrial employment. In response to these trends, several efforts are underway to update vocational technical education and to align that education more closely to the expressed needs of employers and the larger community.

A variety of models and approaches circulate among policymakers and educational practitioners. **One of the most promising of these approaches for industrial technology programs is the kind of partnership exemplified by the one between the Procter & Gamble Manufacturing Company (P&G) in Quincy, Massachusetts, and the South Shore Regional Vocational Technical High School (SSVT) in Hanover, Massachusetts.**

In this report, we describe the early stages—the planning and first-year implementation and outcomes—of what promises to be an effective strategy for vocational technical schools to train a workforce, respond to industry needs, and support the role of vocational education in a community. Because we think that this program's experiences offer insights and guidelines to others interested in developing an industrial technology partnership and an industry-relevant curriculum, we place it in the context of trends in vocational education and trends within manufacturing. In particular, we offer this program as an example of a good, thoughtful partnership between an educational institution and a manufacturing firm. Finally, we make a series of recommendations as to how the specific experience of SSVT applies more broadly to vocational education industrial technology programs in Massachusetts.

We could describe this program as a customized training program, useful only to a single company; however, from the outset, the program was more than that, a point that we emphasize throughout our report. Not only did the program design respond extremely well to the specific needs of P&G for broad-based training in manufacturing-related skills, but both the company and SSVT administrators viewed the program as an opportunity to revitalize an existing vocational technical program as well. As a P&G manager told us, "This is an opportunity for schools to interact with industry and to find out what we really need." In addition, this partnership helped SSVT maintain its manufacturing program and increase that program's viability over the long run.

Specifically, the partnership allowed SSVT to:

- Gain specific information on industry needs and training needs.
- Gain access to current manufacturing equipment and work environments.
- Refine the faculty's and administration's ability to integrate an industry relevant program with an existing vocational program.
- More accurately assess the volume of demand and facilities required for industrial education.

Why should vocational education be interested in manufacturing? In this report, we present quantitative data showing the overall decline of manufacturing employment in Massachusetts; however, we also present and document an argument for the existence of an important demand for education in manufacturing technology that is firm and market specific. In our view, the aggregate statistics of manufacturing employment mask a well-spring of need among manufacturers. We show that this demand for training assistance can be tapped through developing partnerships with industry and that the need for trained labor market entrants, though not large, is strong. **Manufacturing companies are continually adopting new technologies and developing work systems that require workers with different, higher-level skills. Among the majority of the companies that we interviewed, these types of training issues were important to the vision of their company's future.**

## The Program

In 1991, the Quincy division of P&G asked SSVT to design and then offer a training program to P&G employees. P&G was seeking training that would raise the skill levels of their machine operators so that those operators could carry out basic maintenance and repair on sophisticated mechanical and electronic packaging and processing equipment. SSVT administrators responded positively to these inquiries and, with strong support and involvement from P&G, designed a program that met the company's requirements and offered SSVT an opportunity to revitalize its manufacturing program.

In the fall of that year, after a long planning process, the school offered the program to fifty-three P&G employees. The curriculum, a basic course in mechanical skills and concepts, was designed to help students understand the operation of the equipment, to carry out minor repairs, and to troubleshoot basic problems. P&G invested heavily in terms of time and financial resources. As the weight of the research in this report points out, the partners' heavy investment in program design and curriculum development helped guarantee the ultimate success of the program.

The curriculum was performance based. Students demonstrated competencies required by the program by completing tasks to the satisfaction of the SSVT faculty and the P&G training coordinator. Competencies were based on the actual work tasks, including conceptual understandings, that students would need to clean, lubricate, and make minor repairs to equipment in their department. These competencies include:

MATH AND MEASUREMENT
CARE AND USE OF HAND TOOLS
MECHANICAL FASTENERS
LUBRICATION
BELTS AND PULLEYS
CHAINS AND SPROCKETS
BEARINGS
GEARS AND GEAR REDUCERS
COUPLINGS
PUMPS

In addition, the partners and the students felt that the students gained more global competencies in the following areas:

- Ability to recognize potential causes of mechanical failure.
- Ability to perform basic tasks in preventive maintenance, such as cleaning, inspecting, and lubricating machine parts.
- Increased confidence in their ability to work with machines.
- Ability to communicate more effectively with mechanics and other highly skilled employees.
- Enthusiasm about learning and a desire to participate in additional training programs, including further training in troubleshooting.
- Newly acquired knowledge of mechanics that makes their work more interesting.
- "Broader view of their work" in terms of process and maintaining production standards.

## The Broader Market for Industrial Technology

**We found considerable transferability in this program's curriculum.** Although the basic curriculum was designed as a customized training program, other firms that we interviewed endorsed its content and felt that some or all of it would be useful for their workforce. This transferability is due, in part, to the fact that the fundamental processes of manufacturing and machine operation are similar across various industries. More to the point, however, this program's curriculum targeted basic skills that operators in a variety of industries need to increase the productivity and efficiencies of manufacturing processes. To most of the firms that we interviewed, maintaining the nearly continuous operation of the equipment—"producing product," as its called—is of paramount importance. A curriculum that helps machine operators contribute to higher levels of machine usage and less downtime is almost guaranteed to be of interest to manufacturers.

After interviewing management representatives of South Shore manufacturing firms, in such areas as food processing, packaging, metal-forming, pharmaceuticals, and electronics, as well as representatives of industry groups, we concluded that this program has relevance to other industries.

Also of interest is that we found similarly positive responses among the group of labor officials that we interviewed. These representatives of manufacturing workers on the South Shore agreed with the need to develop a more flexible and productive manufacturing workforce, and they were interested in maintaining the health of the manufacturing sector and maintaining high quality employment. Their views on training and on increasing the job responsibilities of their members, however, were closely tied to those members being recognized and fairly compensated for any increase in their value to the company.

P&G's development of an industrial technology program with SSVT was the expression of a sophisticated approach to involving their workforce in their strategies for quality and productivity, an approach that P&G has invested heavily in since the early 1980s. We also found, however, that other firms are beginning to move in this direction as they increasingly view the workforce as an important resource in achieving their market goals. Thus, the firms that we interviewed also expressed a strong interest in developing worker flexibility, problem-solving skills, team and leadership skills, and skills related to quality processes and techniques.

**Despite all of the enthusiasm for the SSVT curriculum as well as the expressed needs for training, we found that both managers and labor officials generally lacked strategies on how to train their workers and had limited knowledge of training resources**. Except for two or three larger firms with whom we spoke, the employers did not have the expertise to plan a comprehensive training program for their workforce. Although representatives of most firms had positive views of vocational education because they themselves were graduates, because they had hired vocational school graduates, or because they viewed vocational schools as an appropriate setting for practical, hands-on training, they—for the most part—had not as yet employed vocational schools as a resource for their own training efforts. This vacuum presents an important marketing opportunity for vocational technical schools.

Based on P&G evaluations and on the responses of the other companies, we identified a number of expansion areas for the basic curriculum discussed here.

- Troubleshooting
- Problem-solving
- Interrelationship of machine parts and functions
- Quality
- Safety
- Electrical/electronic components of machinery
- Advanced manufacturing technologies (robotics, CAD, etc.)
- Technological literacy/communication

Some of these elements, like problem-solving, should be incorporated, to a certain extent, into a basic industrial technology curriculum; others form the basis of an advanced curriculum. (See page 23 for a more detailed discussion of an advanced industrial technology curriculum.)

## Recommendations

Based on our research and our evaluation of the SSVT/P&G program and, in part, influenced by Bay State Skill Corporation's experience in workforce development, we make a series of recommendations about industrial technology programs. These recommendations are directed specifically to SSVT and more broadly to schools and firms that might be interested in creating industry/education partnerships of this type. We present several of these recommendations here:

**For SSVT:**

- To expand their customized training effort, SSVT's administration must actively market this program to the industrial community and then be prepared to communicate at length with and respond to employers and their interests in specific elements or refinements of the curriculum and program design.
- If the program is to be offered to other companies, a greater emphasis on problem-solving techniques and an introduction to, for instance, continuous improvement, team skills, and standard concepts of quality tools and procedures should be integrated into the basic curriculum, which will require staff development and an administrative commitment to curriculum development in these additional areas.
- SSVT's administration should investigate ways of offering specific and detailed course material in problem-solving and team development as well as hazardous waste handling and safety issues, which they may find are too specialized for the basic curriculum.

- Although not a large issue at P&G, many of the firms that we surveyed report language skill needs in their multi-language plants. The school should seek ways of offering or coordinating with an ESL or language skill program.
- Although the program adequately addresses the specific learning requirements and performance objectives of P&G's employees, it is important to find and use a satisfactory method of gauging the validity of the performance objectives for other industries and assessing that skill competence has been demonstrated.
- SSVT should develop ways to more fully integrate adult trainees with the traditional high school students.
- SSVT administrators should formally assess the P&G industrial technology curriculum and take the necessary steps to integrate this material into their regular curriculum as appropriate.
- SSVT should further develop their career awareness program to attract middle school students to SSVT and to the revitalized industrial technology program.
- SSVT should develop articulation agreements and collaboratives based on the revitalized industrial technology program.

**For vocational technical schools and industry partners:**

- Manufacturers can turn to vocational technical schools to help give voice to their need for an educated, involved workforce.
- The manufacturing industry represents a substantial market for customized training and other partnership programs that vocational technical schools should aggressively pursue. Given the potential benefits that can accrue to the schools and industry, schools should develop a marketing plan that targets area manufacturing firms and initially focuses on the schools' current capacities and existing relationships. Likewise, manufacturing companies should seek out vocational technical schools to train their workforce.
- Necessary to the success of such a program as this is an upfront investment of time for planning and exploring the needs and expectations of all partners, a commitment to providing the necessary resources, and a commitment to on-going evaluation and revision. Schools and companies should set clear goals for their training programs.
- Manufacturing companies should make a long-term commitment to a training curriculum *vs.* a single course to provide the skills necessary for the company to realize its business goals.
- Companies should be prepared and willing to invest money and additional resources in training programs.
- In developing a basic approach to providing training for manufacturing firms, vocational technical schools should be flexible in considering the needs, interests, and constraints of the industry partner:
  - Class schedules must be flexible and meet the requirements of the partner firm(s), *e.g.*, days, nights, weekdays, weekends, and flexible hours.
  - The training site should also be flexible, *e.g.*, at the school, on-site at the company, or both.
  - The differing needs of adult students should be taken into consideration as appropriate, *e.g.*, elements of the Special Program Features of the SSVT/P&G program.

- In general, training programs should combine job-related theory and hands-on learning and include such broadly applicable skills as troubleshooting, critical thinking, problem-solving, communication, and teamwork skills.
- Vocational schools should plan to integrate adult and high school students in classes but should anticipate possible resistance to this effort and plan accordingly.
- Vocational technical schools should transmit a more positive and realistic image of the manufacturing field to students and implement aggressive industrial technology career awareness programs to include orientation sessions, career/job fairs, and sample classes and labs, evaluating and revising them as necessary.

In conclusion, by all accounts, the first year of the SSVT and P&G Industrial Technology Program was a success. But this is just the first step: They are now in the process of planning the next year. While some program elements are unique, the program both exemplifies several trends in vocational education and highlights the synergism between the direction and the needs of vocational education and those of manufacturing. Such partnerships make sense and should be pursued by both parties. We offer this analysis and our recommendations as a basis for and a guide to creating manufacturing partnerships.

# INTRODUCTION

## *STILL MAKING IT IN MASSACHUSETTS: MANUFACTURING*

*As of 1989, Massachusetts was home to just under 11,000 manufacturing firms, an industry group that employed about 21% of the total labor force. Although Massachusetts manufacturing has been hard hit by the recession, it is important to keep in mind the continuing important role that manufacturing plays in our economy. These firms had—again, in 1989—an annual payroll of $17.5 billion, which is just over 26% of the total wages paid to all employees. The average wage per manufacturing employee was $29,000 compared to $17,400 in the trade and $22,100 in the services sectors.*

*What gets made in Massachusetts includes just about everything except cars and trucks and heavy industry. Six manufacturing sectors—machinery, electronics, instruments, fabricated metals, textiles, and rubber and plastic goods—account for 50% of the manufacturing firms and for 56% of the total manufacturing employment. Due to the skill requirements in important industry segments such as metal working, instrumentation, and electronics as well as losses in the larger mass production industries, Massachusetts has a concentration of manufacturing firms that employ a skilled workforce.*

*Small firms are the heart of Massachusetts manufacturing. Only 170 companies in the state employ more than 500 workers, and only another 250 employ between 250 and 500 people. All the rest, some 10,000 firms in 1989, employ fewer than 250 people; 90% employ 100 or fewer.*

*Small- and medium-sized companies are the backbone of our manufacturing economy.*

All statistics, County Business Data Department of Commerce, 1990

**This report summarizes and assesses the planning and first-year implementation of the Industrial Technology Program created through a partnership between South Shore Vocational Technical High School (SSVT) and the Procter & Gamble Manufacturing Company (P&G).** Further, it provides a frame of reference and a guide for the development of similar programs by relating this program to trends in industry and education. Begun in the fall of 1991, the training program was created specifically to prepare operators of packaging machinery at P&G's Quincy, Massachusetts, soap manufacturing plant to perform higher level mechanical tasks, such as machine maintenance and troubleshooting.

Originally designed by P&G, the program curriculum was refined by the partners to accommodate both the specific skill requirements of the Quincy plant and the facilities and instructional capacity of SSVT. To date, fifty-three P&G employees have been trained in the program.

Because an important aspect of customized training programs such as this one is that they can help revitalize and develop industrial technology programs in vocational education schools, school administrators planned to evaluate the fully implemented program in order to integrate its curriculum into the existing SSVT manufacturing program. To aid them in their efforts, Bay State Skills Corporation (BSSC) reviewed program records, conducted a series of interviews, and held a focus group. We relied on the descriptive and qualitative responses of these interviewees in compiling this report. Interviewees included:

- an SSVT administrator and faculty member,
- program completers (all P&G employees),
- the P&G training coordinator,
- several production managers,
- management representatives of fourteen area manufacturing firms,
- five elected labor officials, and
- representatives of industry groups.

We also spoke with educators in Massachusetts and around the country to gather information on trends and to determine where this particular program fit in the spectrum of innovations in vocational education. (See Appendix A.) Although it is impossible at this early stage to determine the long-term impact of this program on its students and partners or to evaluate the program empirically, the anecdotal, or self-reported, impact provides clear evidence of the program's value.

The report begins with a description of the planning and development processes undertaken to create this program. It was clear from the beginning of our assessment that the partners' strong commitment to significant up-front planning and program design, on-going evaluation and revision, and contribution of resources were important determinants of the program's success to date. In the spirit of that commitment, we have included the detail necessary to make the program outline useful to those who may seek to replicate or adopt this approach.

The report also provides an overview of the partners' original goals and desired outcomes and assesses the curriculum and first-year outcomes as they relate to the expectations of P&G (both managers and machine operators), SSVT, labor officials, and other manufacturing firms.

In addition, the report places considerable emphasis on the relevance of this curriculum to the changes taking place in U.S. manufacturing. At the forefront of developing new work structures and adopting advanced technologies, P&G has as a business strategy the incorporation of the newest applied manufacturing technologies; the reorganization of the structure of work; and a set of management principles that promotes and enforces product quality, customer satisfaction, and human resource potential. Key to this competitive strategy is a skilled workforce, capable of fully participating in an integrated work system, and a national policy of investing in the skills of its workforce.

In general, P&G's workforce is organized into teams. Team members are cross-trained in different jobs and work toward common goals, a practice that tends to break down the distinctions between semi-skilled, skilled, and technical functions. Because supervision of the teams and many management positions rotate, workers are encouraged to develop leadership skills through education and training in team building and leadership skills. P&G also offers strong internal job ladders; relatively few people are hired from the outside to fill upper-level assignments. P&G also rigorously screens new hires, not only for the prerequisite technical skills but also for the social skills required in teams. P&G's interest in integrating higher order skills and knowledge for machine operators (technicians) into its operations had a profound impact on the design of the program at SSVT.

Having machine operators become more flexible through the acquisition of skills, do troubleshooting, and carry out maintenance tasks on their equipment was a major goal. Traditionally, a strict division of labor and sharply defined hierarchies of responsibility controlled each person's job tasks. P&G's move away from the traditional organization shaped the way the SSVT Industrial Technology Program curriculum was developed and implemented.

While P&G is in the forefront, other manufacturing firms are also addressing these trends. Those firms that we interviewed for this report are, like P&G, in traditional manufacturing industries, including food processing, pharmaceuticals, paper goods, machinery, and metal-forming. These interviews support BSSC's findings that many Massachusetts manufacturing firms, although maybe not as far along as P&G, are exploring or have begun implementing systems that integrate technology and the workforce in ways that they hope will enhance their firm's competitive stature. Generally referred to as "total quality systems" or "high performance work systems," these systems aim to increase productivity levels, maintain or improve product quality, and solidify a market position. A key element in all these systems is a skilled and involved workforce. This apparent requirement for such a workforce demands the creation of skill development programs such as that implemented at SSVT.

Because of its resources and progressive history, P&G is articulate in its needs for skill development. Other firms are not so articulate and require educational institutions to help give voice to their need for an educated and involved workforce. The need for this type of development exists, both for the current workforce through customized training and for students who will enter the labor force through the regular curriculum of vocational technical education. Further, given the increased pressure on manufacturing firms to develop new work structures that require expanded workforce skills, programs such as SSVT's, are important to the health of the Massachusetts' manufacturing sector and general economy.

This report further explores these industrial trends in terms of the labor demands that they create. The overall decline of manufacturing activity in Massachusetts is viewed in relationship to the growth potential—albeit limited—in specific, higher-order, manufacturing skill areas. We find that the Industrial Technology Program curriculum provides a solid foundation for these skill areas, although it should be expanded to further enhance the employability of its students, and we provide recommendations for the expansion of this curriculum and the development of new course material.

One of the important findings in the review of this program is the relatively high demand for analytical, problem-solving, communication, and team-building skills. For the most part, manufacturers and labor officials alike agree on the need for changing and expanding the scope of responsibilities and the requisite skills for machine operators. Underlying this interest is the common concern about the competitiveness of manufacturing and the general focus on involving the workforce as a strategy for revitalizing industry. We call these skills a "value-added" component to vocational technical education because they go beyond imparting traditional technical skills and significantly increase the ability of a worker to make contributions to the company's success.

We find that only a few vocational programs have ventured into education that centers around new work structures or working in teams, even if that venture is congruent with and encouraged by the language of the new Perkins Act. The SSVT program curriculum includes specific, basic skills required in a range of industries and offers a framework for incorporating important "new" skills. The challenge for SSVT and other vocational technical schools is to further integrate and emphasize problem-solving, analytical, communications, and teamwork skills.

The report concludes with recommendations targeted at three audiences: SSVT, Massachusetts vocational technical schools, and Massachusetts manufacturers. Although the immediate value of this report is to provide the partners in the SSVT/P&G program with reflections on their achievements as well as suggestions for next steps, we hope it has a broader value as well. To the vocational technical schools and companies who seek to develop industry linkages and customized training programs, we offer this report as a guide to developing effective education/industry partnerships.

# DEVELOPMENT OF A PARTNERSHIP

## *A CENTRAL FINDING:*

*A heavy investment in planning was crucial to a successful first year and to a genuine sense of program ownership for both partners.*

In September 1991, South Shore Vocational Technical School, located in Hanover, Massachusetts, offered its first training program for industry: an industrial technology program developed in partnership with a division of the Procter & Gamble Manufacturing Company, located in Quincy, Massachusetts. For over a full year, the partners planned and negotiated, together developing clear goals, an understanding of each other's interests, and finally, a strong commitment to the success of the program.

In this section, we discuss the structure of the program as originally conceived and the planning process. While some of the elements of the original design have not yet become fully operational (identified here and in other sections of this report), the program planning was clearly based on a vision of integrated and revitalized manufacturing education held by the administration and some of the faculty at SSVT. We provide the following description of this planning in order to emphasize the strategic importance of such a comprehensive approach. To begin, see the following chart for the key steps to be taken in program development.

**Chart I: PHASES OF PROGRAM DEVELOPMENT**

**I.** Identify needs of all partners (include companies, school, trainees, unions, school committee, etc.)

**II.** Begin negotiations with the partners' representative decision makers to preclude potential roadblocks.

**III.** Establish a clear set of goals or program outcomes.

**IV.** Research/review existing curricula.

**V.** Develop curriculum.

**VI.** Identify needs relative to curriculum (personnel, materials, supplies, classroom space, lab or practice, program logistics, scheduling, etc.)

**VII.** Continue negotiations around each partner's level of support and commitment to the program; identify other areas of support where needed.

**VIII.** Establish liaison relationships and lines of communication for program implementation.

**IX.** Implement the program.

**X.** Evaluate and then improve the program continuously.

**XI.** Take the next steps.

## P&G's Need

At P&G's Quincy plant, one of the competitive strategies is to improve quality and productivity by giving employees more responsibility for preventing mechanical failures that could interfere with or stop production. If more employees were able to prevent mechanical failure, machine downtime would be reduced, thereby lowering costs incurred by lost production time. In addition, if more employees were able to perform preventive maintenance procedures, P&G's mechanics would be able to concentrate their attention on more complex mechanical tasks that require their particular expertise.

In order to develop employees' skills in preventive maintenance, P&G officials decided to implement a training program in basic mechanics. In seeking a vendor from outside the company to provide the training, P&G determined that the vendor would have to be able to:

1. Work with the P&G training coordinator to develop the training program according to P&G's specifications.
2. Provide applied "hands-on" training in basic mechanics, not theory only.
3. Be recognized by employees as a legitimate provider of education and training.
4. Provide the services of an appropriately credentialed instructor.
5. Accommodate the particular needs of adults in the workplace, including appropriate scheduling, pacing of instruction, and procedures for performance evaluation.
6. Offer instruction at an appropriately equipped site away from the plant, yet easily accessible to employees.

## SSVT's Need

Like its counterparts in Massachusetts and throughout the United States, SSVT is experiencing a decline in enrollments, particularly in its manufacturing and mechanical programs. In Massachusetts, the number of students in the high school population declined by 31% during the 1980s. As a result, SSVT and other secondary schools are seeking new markets for their services. For SSVT, providing training for industry and for adult populations was the logical step necessary to sustain its enrollments, to retain an important role in the communities that it serves, to increase the relevance of its programs for noncollege-bound students who enter the workforce immediately upon graduation, and to revitalize its programs.

In developing a strategy to recruit clients from industry, SSVT's officials determined that those companies would have to:

1. Be willing to work with instructors and administrators to develop a training program customized to the client's specifications.
2. Desire the "hands-on" approach to training that is characteristic of vocational education.
3. Be willing to have their employees participate in classes with high school students at SSVT.
4. Be willing and able to pay for instructional costs, including instructors' salaries and benefits, as well as instructional equipment and supplies.

## A Partnership Evolves

P&G and SSVT met each other's basic requirements. In January 1991, P&G initiated meetings with the SSVT to explore the potential for developing a program to update the basic industrial machine technology skills of current employees. SSVT welcomed the idea. Their own industrial technical skills program was not attracting students and was scheduled to be eliminated in FY '92. The superintendent of SSVT saw the overture from P&G as an opportunity to develop a new relationship with industry as they revitalized their manufacturing program.

Over the next six months, P&G and SSVT held numerous and frequent meetings. They also met with the South Shore Regional School Committee as well as SSVT's Massachusetts Teachers Association union representatives. During the early phases of curriculum development, school administrators, P&G managers, and members of the P&G workforce met weekly; however, at the beginning of the process, the administration of SSVT and P&G met several times to develop the program concept and to create an outline for the curriculum. Discussion in the early meetings established some broad areas of mutual interest and recognized certain themes:

- The system of manufacturing that has prevailed over the last century is giving way to more effective high performance organizations. Some of the characteristics and skills needed by today's and tomorrow's workforce . . . in a new system of work organization will include the ability to analyze and solve problems, the knowledge and willingness to work cooperatively in the decision-making process, and the ability to be flexible performers in the workforce by being prepared for a variety of new roles.
- It would be in the best interest of both industry and vocational technical education if they were able to seek cost effective ways to jointly provide services to broaden the scope of skills training for those currently in the workforce . . . and for those preparing to enter it.
- It would be of mutual value to establish a partnership . . . that would link one or more of SSVT's programs with contemporary industrial processes, standards, and up-to-date equipment (now in use) in the industrial community within the placement area of the school's students. A clear benefit to SSVT students would be exposure to current career skills, workplace organization, and career opportunities.

(Concept Paper: Procter & Gamble/South Shore Regional School District, 1991)

### Goal development:

These broad concepts led to the formation of a set of program goals. The program goals were designed to maintain a fairly broad focus on current issues of workforce development and, at the same time, by virtue of the principal industrial partner, narrow the program content to the industrial technology skills associated with the machine processing and packaging industry in metropolitan Boston. Effectively, P&G largely defined the industry training needs. Rather than excessively narrowing the training curriculum, they expressed a remarkably comprehensive set of skill development interests and, because of their progressive approach to work structure, introduced state-of-the-art concepts of integrating technical skills with advanced forms of work organization.

In many ways, P&G was an ideal industrial partner for a vocational technical school attempting to revitalize its manufacturing program. The goals of the program (again quoting from the original joint concept paper) included elements that, while attractive to P&G, enabled SSVT to maintain and then to transform its manufacturing course into a viable industrial technologies program. The joint goals included developing the following:

- A model articulation agreement . . . aimed at developing an industry/education partnership to address specific technical workplace needs with a responsive and technically current training program.
- An industrially validated curriculum that will serve as a generic technical and academic skills training base for both industry and vocational technical high school students.
- A secondary school vocational technical curriculum that is designed to effectively train a flexible and adaptable future employee capable of being cross-trained and contributing to the improvement of workplace productivity through interactive problem-solving and decision making.
- A realistic training center that closely simulates and models the technical, safety, and procedural environment found in related industries.
- Instructional strategies that enhance the efficacy of adult and secondary students working and learning in an industrial education and training environment.

**Planning committees:**

Two committees were created; both included company and school representatives as well as others. The Planning Committee was responsible for defining the organizational and content needs of each partner, identifying logistical issues, identifying resource needs, defining parameters of the program, and developing the specific language for the contract/agreement between the company and the school.

The Technical Training and Development Support Committee provided technical assistance in program development and, when necessary, found additional funding to support the program. This group also explored the potential of replicating the program in other industries.

**Partner contributions:**

From the outset, P&G responded generously to the opportunity to use an off-site instructional program and facility that already had a reputation for quality instruction. The company agreed, in writing, to provide:

- Technical equipment, materials and supplies to support the technical training program.
- A curriculum content in use at other P&G plants that had been validated to specific skill structures for manufacturing and industrial technicians (elements of which are proprietary information) developed by the company in 1989 in accordance with their plant design guidelines.
- Salary and benefits for the SSVT instructors assigned to the program.
- Additional funding for support staff and administrative costs.
- Opportunities for SSVT faculty to visit P&G to gain information on new production technology.

SSVT, in turn, agreed to provide:

- The instruction according to the agreed curriculum.
- Flexible scheduling to accommodate P&G shift schedules, including Saturday instruction.
- Facilities and ancillary equipment for instruction.

- Access to other SSVT educational and technical program components on an as-needed basis.
- Certification of skills mastered by secondary and adult students in the program.

**The process of curriculum development, implementation, and revision:**
Originally designed by P&G, the curriculum, which is discussed in detail in the following section (page 11), was revised, updated, and adapted specifically for use with machine operators at the Quincy plant and to accommodate the facilities and capacities of SSVT. Considerable planning was required to integrate the company's interests with SSVT's teaching and instructional imperatives.

In particular, the company had no real interest in the standard academic criteria for success or failure or in demonstrating knowledge through testing. The joint Planning Committee decided to proceed with a performance-based approach, which required that students had to be able to demonstrate specific skills and knowledge before they would be certified as having completed the unit of instruction. The school agreed that there would be no strict time limits on how long it took a trainee to complete each curriculum unit; completion occurred when the trainee successfully demonstrated a mastery of the designated skills. This compromise created some obvious disjunctures between the training for P&G employees and the academic requirements for high school students who might wish to enter the program because SSVT's academic/vocational program is only partly performance-based.

Both the school and the company agreed to review and adjust the curriculum as needed throughout the course of the program. P&G always had at least one, and sometimes two (a project manager and the training coordinator), staff serving as liaison between the plant and the school. To assure that P&G's industrial standards for skill development and curricular consistency would be maintained, the training coordinator assisted the instructor on the school's shop floor, where students put into practice what they learned in the classroom. The coordinator also surveyed P&G supervisors and team leaders to gather information regarding the efficacy of the instruction and learning, providing feedback to the instructors, and helping revise the curriculum as necessary.

**Personnel:**
The partners built a high level of staffing and coordination into the program. Besides having a project manager and a training coordinator oversee the program, both the joint planning committees continued to function in an advisory and oversight capacity. The principal of SSVT's Abington campus coordinated and monitored the program. His primary role was to assure that communication between the partners was maintained at an effective level and that secondary students were integrated into and benefitted by the instruction program.

The original program design called for three technical instructors to be hired who were Department of Education approved or who could be approved under Chapter 74 regulations. In fact, three instructors were hired, but only two taught in the Industrial Technology Program. Of these two, one was primarily responsible for SSVT's students, while the other was most often engaged with P&G's adult learners. Both teachers "crossed over" when it was appropriate to do so or when joint adult and secondary-student projects were undertaken. The teacher assigned to the adults also served as program manager, supervising the shop as well.

**Facilities:**

The project operated at SSVT's Abington Campus in the former manufacturing shop. This renovated gymnasium houses a variety of industrial packaging and processing equipment as well as a small machine shop and elementary welding equipment. In addition, the program used a small enclosed classroom area and an adequately sized tool crib also within the gym. As was mentioned earlier, P&G enhanced the facilities by providing additional tools and equipment.

**Integration of adults and secondary school students:**

One of the more innovative aspects of the original program design was the integration of high school age and adult learners into the program, and one planned outcome of this project was to design and evaluate effective ways to integrate adults into such programs because of the educational benefits and the exposure of students to industrial careers and workers. However, during the discussion and approval phases, the faculty and school committee expressed a great deal of concern about this aspect. While third- and forth-year students were partially integrated with the adults, full integration did not occur, and younger students remained largely segregated from the adults. Future plans call for further integration.

**Financial relationship:**

A contract developed by the Personnel Operations Manager for P&G and the Superintendent-Director of SSVT specified fiscal matters pertaining to the project. The contract was subject to review, alteration, and approval by the plant manager of P&G and SSVT's School Committee. P&G committed a relatively large amount of funding and in-kind contributions to establish the program and paid regular wages to employees attending the program, including compensation for travel.

**Training schedules:**

Training schedules were subject to the company's shift policy and SSVT's daily class schedule; participation was voluntary. Students who chose to attend were released from the first or last four hours of their twelve-hour shifts. Two groups were trained at the school each day and two groups on Saturdays. Saturday instruction was subject to the approval of the faculty union. The program could accommodate up to six training groups of between six to ten employees during a cycle. Each training group was scheduled for two 3 1/2 hour sessions per week; training followed the school schedule and ran between 8:00 A.M. and 2:30 P.M. Three twelve-week cycles ran during the first year.

**Approval:**

The regional school board, faculty union, and P&G approved the program—largely in its original design, with modifications in staffing and on the degree of integration of the high school students and adults—in the late summer of 1991. The program began in September 1991. A description of the program, including the program goals, performance outcomes, and important features of the instructional process, is provided in the following section.

# THE PRODUCT: A JOINT INDUSTRIAL TECHNOLOGY CURRICULUM

### *A CENTRAL FINDING:*

***Students not only attained the basic competencies as outlined in the program but also achieved broader outcomes that enabled them to be more flexible and productive.***

For schools committed to developing customized training programs, the client's goal must be paramount. SSVT's instructors worked closely with P&G's program manager, training coordinator, managers, and technicians to ensure that the students' developed a wide range of competencies in basic mechanics. In describing the goal of the training, P&G's training coordinator emphasized that the program was intended to give students "both cognitive skills and hands-on skills" in basic mechanics, so that they "can recognize what's going wrong before it becomes a real problem." In designing the program to meet that goal, the coordinator and SSVT's industrial technology instructor determined that the program should include instruction and practice in 68 competencies in the following categories: Math and Measurement, Care and Use of Hand Tools, Mechanical Fasteners, Lubrication, Belts and Pulleys, Chains and Sprockets, Bearings, Gears and Gear Reducers, Couplings and Shaft Alignment, and Pumps.

## Chart II: INDUSTRIAL TECHNOLOGY PROGRAM COMPETENCIES

### A. MATH AND MEASUREMENT

1. Add and subtract ruler fractions.
2. Add and subtract mixed numbers.
3. Add and subtract improper fractions.
4. Add and subtract decimals.
5. Convert fractions to decimals.
6. Use measuring tools, including micrometers, dial calipers, and dial indicators.

### B. CARE AND USE OF HAND TOOLS

7. Use hand tools, including screwdrivers, C-Clamps, hammers, pliers, wrenches, bench vices, pullers, and torque wrenches.
8. Understand and apply safety rules for handling tools.

### C. MECHANICAL FASTENERS

9. Measure threaded fasteners.
10. Identify and describe the use of each type of mechanical fastener, including screws, bolts, nuts, washers, snap rings, pin fasteners, and keys.
11. Select and install each type of mechanical fastener.
12. Remove each type of mechanical fastener.

### D. LUBRICATION

13. Explain the importance of lubrication.
14. Understand the uses of different types of lubricants.
15. Lubricate machine parts.
16. Check oil levels.
17. Change oil.
18. Handle, store, and dispose of oil.

### E. BELTS AND PULLEYS

19. Identify types of belts, including V-belts, poly V-belts, flat belts, and timing belts.
20. Identify types of pulleys, including fixed sheave, adjustable sheave, crowned pulleys, and flanged pulleys.
21. Remove pulleys.
22. Install pulleys.
23. Measure belts for identification.
24. Troubleshoot belt and pulley failures.
25. Remove guards.
26. Install guards.

### F. CHAINS AND SPROCKETS

27. Identify types of chains, including roller, rollerless, light-duty, heavy series, single and multiple-strand, and conveyor.
28. Measure chain.
29. Identify types of connecting links, including master links and half (offset) links.
30. Cut lengths of chain.
31. Understand sprocket tooth/RPM relationships.
32. Remove a chain drive.
33. Reinstall and align sprockets.
34. Install chain and connecting link.
35. Adjust tension.

## G. BEARINGS

36. Understand the effects of friction.
37. Identify types of bearings, including plain (sleeve), anti-friction (roller), flange bearings (pillow block), thrust, and radial.
38. Describe bearing fits and tolerances.
39. Explain the use of lubrication charts
40. Lubricate a bearing.
41. Explain the safe use of tools for bearing removal and installation.
42. Remove a bearing.
43. Replace a bearing.
44. Align a bearing.
45. Describe the warning signs of impending bearing failure.
46. Troubleshoot and analyze the cause of a bearing failure.

## H. GEARS AND GEAR REDUCERS

47. Understand gear-related terminology, including such terms as backlash, helix, parallel, perpendicular, reducer, input shaft, and output shaft.
48. Identify types of gears, including spur, helical, worm, bevel, and spiral bevel.
49. Understand the uses of gears.
50. Disassemble reducers.
51. Replace bearings.
52. Replace seals.
53. Replace gaskets.
54. Replace gears.
55. Perform preventive maintenance.

## I. COUPLINGS AND SHAFT ALIGNMENT

56. Identify types of couplings, including rigid (flanged and sleeve), mechanical flexible (gear, chain, grid, and universal joint), and material flexible (spider, spring, rubber tire, flexible disk).
57. Describe coupling maintenance requirements.
58. Lubricate couplings.
59. Remove couplings.
60. Inspect couplings.
61. Replace couplings.
62. Align couplings.

## J. PUMPS

63. Understand pump nomenclature, including inlet (intake low side), discharge (output high side), and ports.
64. Identify the parts of pumps, including parts of a simple positive displacement piston pump, a centrifugal pump, a diaphragm pump, an internal gear pump, and a sliding vane pump.
65. Understand the theory of operation for each pump.
66. Understand the maintenance requirements of each pump.
67. Disassemble pumps.
68. Reassemble pumps.

## Performance Outcomes

Competencies in the above categories and subcategories became expected outcomes for the program's first-year operations. Additional, more global outcomes, however, were hoped for and observed as a consequence of the instruction. Both employees who participated in the training and P&G officials who established the program goals have agreed that the customized training program accomplished their goals. Students who completed the training program have achieved the competencies listed on above. For greater detail on their impressions, see the following section (page 17).

## Additional Outcomes

The more global outcomes that resulted from the employees' skill achievement in this customized training program include:

1. Program participants are able to recognize potential causes of mechanical failure. They can anticipate when a problem might occur and, therefore, take appropriate actions to prevent it.
2. Program participants are able to perform basic tasks in preventive maintenance, such as cleaning, inspecting, and lubricating machine parts. These tasks were previously performed by maintenance staff, which was, reportedly, an inefficient use of employee skills and time.
3. Program participants have more confidence in their ability to work with machines. They report that they are more willing to take on tasks—with training—that involve new or different machinery. The best example of this new-found confidence occurred when a program trainee volunteered to work on a "change-over" team. This team prepares machinery to accommodate production of a different product, and their work involves more advanced technical skills, like adjusting controls and installing parts.
4. Program participants are now able to communicate more effectively with mechanics and other highly skilled employees. This ability significantly reduces the amount of time a mechanic spends identifying the source of the problem. According to one P&G mechanic, the common complaint from operators had always been that the machine "is broken," with no further clarification of the type or extent of the problem; now, operators can help pinpoint the problem.
5. Program participants are enthusiastic about learning and want to participate in additional training programs, including training in troubleshooting. They take advantage of programs that are offered on-site, and some are looking at college degree programs in the area.
6. Program participants report that their newly acquired knowledge of mechanics has made their work more interesting. Morale on the job is enhanced, and more attention is paid to the job details as a result.
7. Program participants describe themselves as "having a broader view of their work," *i.e.*, they can "see the big picture." They report understanding how their job function relates to other functions on the production line and to the plant generally.
8. Program participants are able to use their mechanical skills outside of the workplace, in such ways as repairing automobiles and washing machines.

## Special Program Features

The design of this customized training program in industrial technology incorporates a number of features that address the learning requirements of adults in the workplace, including instructional content clearly related to work tasks, instruction paced according to the needs of each student, integration of academic and technical skills, the provision of ample opportunity for practice, and ongoing evaluation of performance. Each of these features is described below.

### Content clearly related to work tasks:

As mentioned above, the training coordinator at the Quincy plant and SSVT's industrial technology instructor identified the program competencies in response to P&G's training goals. Students have reported the direct relevance of the training content to their work, commenting that "Paul [the instructor] taught us what we needed to know" and that "Paul taught us the real-life way." Further, to ensure the connection between the training activities and each student's job, P&G arranged for each student to have a "sponsor" at the plant. The sponsor's responsibility was to see that students had opportunities for supervised application of the skills acquired in the program.

Implementation of the sponsor function has been the most difficult aspect of the training program. Both P&G and SSVT continue to work to improve the sponsorship feature. For example, P&G's training coordinator and SSVT's instructor have developed specific activities to be completed jointly by each student and her/his sponsor.

### Instruction paced according to students' needs:

Employees who participated in the customized training program included those who had no mechanical knowledge and skill as well as those who had some knowledge and skill in mechanics. The program was designed to accommodate the wide range of students' knowledge and experience. The theoretical portion of instruction was presented through transparencies and handouts, followed by hands-on application of the theory. For example, students studied materials from the Packaging Machine Manufacturers' Institute, engineering information supplied by machine manufacturers, the Machinery Handbook, and numerous trade journals. Then, in the lab, the students applied the theory that they had studied by practicing on various packaging machines provided by P&G, including wrapping machines. Students have agreed that the instructor did not "move on" to the next topic until it was evident that every student had understood the information presented. At times, the instructor worked individually with a student or two, while the others practiced other skills, in order to not lose the motivation of those who were ready and capable of moving forward. In addition to receiving help from the instructor, students received assistance from P&G's training coordinator, both at the school and at the plant, as well as their plant sponsors.

### Integration of academic and technical skills:

People learn more effectively when instructional content is related directly to a meaningful, and often practical, task. For workers, effective instruction has to be directly related to their jobs and their job setting. As a program example, the math required for measurement was taught in connection with performing measurement tasks related to work.

**Ample opportunity for practice:**

People learn at different rates according to their prior knowledge, experience, and aptitude. With twenty-four class and lab sessions and each session three and one-half hours in length, students were given the ample opportunity that they needed to practice each competency. In fact, students were able to practice each competency until they mastered it.

**Ongoing evaluation of performance:**

Providing students with frequent feedback regarding their performance is an especially important feature of performance-based training. During the program, students received constant feedback and evaluation from the instructor and training coordinator and were able to modify their performance as required.

# FIRST YEAR OUTCOMES: RESPONSES OF INDUSTRY AND LABOR

**A CENTRAL FINDING:**

*The SSVT/P&G Industrial Technology Program enhances skills in manufacturing processes. These skills are transferable to other industries and companies that are beginning to view the workforce as a resource and as a source for quality and productivity.*

This section addresses the validation of the program curriculum by its end users—industrial managers and the labor force. Our analysis has two objectives: first, to determine the responses of P&G's management and its employees, the trainees in the program; second, to provide SSVT with the perspectives of others regarding the applicability of the curriculum to and their interest in workforce development in their firms and industries.

The BSSC research group interviewed the P&G training coordinator, production managers, and several machine operators and mechanics who participated in the SSVT program. We also contacted and conducted interviews with managers from fourteen manufacturing firms representing a variety of industries in the SSVT service area: food processing, packaging, metal-forming, pharmaceuticals, and electronics. In addition to geographic location, our criteria were size (more than forty-five workers) and diversity. We also interviewed five representatives of organized labor from other South Shore firms, asking them fundamentally the same questions concerning the curriculum and interest in workforce development.

To complete our analysis, we interviewed representatives from manufacturing trade groups and the South Shore Chamber of Commerce. (See Appendix A, page 63, for a detailed list of interviewees.) Interviews were conducted one-on-one or in small groups (four participants or fewer), and usually took between one and two hours each to complete. Interview instruments (see Appendix B, page 65) were designed to gather data in four categories: the current structure and responsibilities of the machine operator position, the optimal structure and responsibilities of the machine operator position, the relevance of the curriculum to industry needs, and suggested curriculum revisions in light of trends within manufacturing.

Overall, the responses clearly substantiate the relevance of the SSVT industrial technology curriculum to the needs of area manufacturers. The curriculum and competencies, even though designed primarily for the needs of a single firm, were applicable to all of the firms that we surveyed. While each firm had varying levels of agreement in the rank order of relevance of specific curriculum topics, the total curriculum was clearly appropriate for the range of firms represented, allowing many firms to offer concrete suggestions for enhancements.

Of critical importance in the longer run is that our interviews tapped into a strongly felt need for better skills and better training. We discuss this elsewhere in the report, but its importance requires emphasis here. A movement is now gathering strength in manufacturing to emphasize skills development and to view the workforce as a resource and as a source for quality and productivity. This movement translates into training. A substantial portion of our interviews involved discussing the general need for skills training.

In these discussions, we identified a knowledge gap—employers and labor officials do not know how to effectively translate a need for training into concrete action steps. Few of those managers with whom we spoke had any workable plan for training or knew of specific resources available to train their workers. These individuals have not widely used the public vocational education system as a resource. In fact, industry, generally, has relatively little specific information on resources and options for workforce development.

When discussing the SSVT industrial technology curriculum specifically, employers clearly saw it as a first step in preparing machine operators for technological and work organization changes taking place in manufacturing. Although responses to our questions were framed by the specific operations of the respondent's company, several key, common points appeared:

- Manufacturing workers need more flexible skills that can be adapted readily to product and process changes.
- Critical thinking and problem-solving skills are becoming the foundation for manufacturing skills.
- Production workers need to become more technologically literate in order to communicate effectively on the job.
- Many employers want to involve employees in building product quality and in understanding the importance of customer satisfaction to success in a competitive manufacturing environment.
- More skill development is needed in the area of troubleshooting or anticipating problems before they occur.

## P&G: Student and Management Perspectives

P&G machine operators who completed the SSVT program were interviewed about the curriculum and its relevance to their jobs. In addition, we interviewed plant supervisors and management. The overwhelmingly positive and enthusiastic responses of both the students and management staff at P&G indicate that the Industrial Technology Program provides a solid, useful set of skills for machine operators. Direct relevance was reported almost unanimously. The one technician who felt differently said that the curriculum did not go far enough into the electro-mechanical aspects of machine technology, which is important to her because of the type of machinery she uses.

> ***"The course helped me do a better job."***
>
> **Kelly, P&G machine operator**

Kelly's statement summarizes the thoughts and feelings of all the trainees. They reported that they were more productive because they could keep their machines running longer between breakdowns than before. They also provided us with anecdotes to support their claims. One technician cited a time that she fixed a machine that wasn't working by brushing dust particles from an electronic eye. Another talked about making simple adjustments to chains and sprockets when the machine was not performing to specification. Prior to taking this course, these problems were dealt with by machine mechanics. Others mentioned that because they now understood the relationship of cleaning and lubricating to machine operations and performance, they could do a better job with these functions, a point corroborated by their supervisors. Since their training, these employees had kept their machines running better and for longer periods of time before they malfunctioned.

> ***"I notice a real difference. I feel more confident in what I do. And I can learn more."***
>
> **Kevin, P&G machine operator**

Machine operators also reported being able to communicate better with mechanics and line supervisors when their machines were either inoperable or out of specification. They described situations in which they were able to identify the specific problem or actual part that was malfunctioning when reporting to the mechanic. The mechanic then arrived with the appropriate parts and tools to complete the job.

Before taking this course, operators saw machine breakdowns as a challenge that they were incapable of tackling. Standard practice was to have a supervisor call maintenance "because the machine was broken." The maintenance mechanic would then examine the machine, which could take a great deal of time if he or she didn't know where to begin, before proceeding with repairs. Sometimes a mechanic would have to go through a time-consuming trial and error process. It was not uncommon for a maintenance mechanic to make several trips to the supply closet, having taken the time to replace parts that needn't have been replaced, before a machine was finally operational again.

> ***"This course broke down the walls between operators and mechanics."***
>
> **Jay, P&G maintenance mechanic**

As mentioned above, machine operators who have completed the course are better able to identify and communicate machine problems, which Jay went on to say makes him more efficient, too, because he can now pay more attention to the more complicated problems without distraction.

Management at P&G shared Jay's perspective. **Don Gardner**, former human resources director at the plant and now head of their chemicals line, placed the program in the context of P&G's approach to new technology and new work organization:

> ***"Our philosophy and practice requires multi-skilling of the workforce.... This curriculum was an important statement that we are serious about training the workforce."***

**Stu Nickerson**, team leader and one of the original committee members to design the program, identified the practical need to **"have people make routine repairs and adjustments to packers and loaders and to have more highly skilled people concentrate on improving the business."**

For both managers, the curriculum fit these needs. Gardner noted that the original curriculum was designed mainly for the packaging line only, but they found that it was applicable to several areas in the plant. According to Gardner,

> ***"Things [competencies] are transferable; people from the chemical lines and elsewhere who have taken the course have raised their general level of mechanical knowledge."***

Gardner, Nickerson, and **Don Rowell**, the training coordinator, were careful not to oversell the role of the curriculum in developing skills and to make certain that we understood that management viewed this curriculum as one relating to basic skills, as a foundation for the later development of higher skills:

> ***"The purpose of the program was to raise the general technical level of the plant, not to develop very high skills."***

They also noted, however, that both the company and the school made "mid-course corrections" to the curriculum. P&G found itself modifying expectations on the level of repairs and adjustments that line operators should make. As a result, the focus is now on cleaning, inspection, lubrication, and identification and diagnoses of more significant repair needs. This shift in emphasis required P&G staff to work closely with SSVT faculty to make appropriate changes in the emphasis of the curriculum as the program progressed.

All management personnel interviewed felt that P&G's investment in the program was sound and that the present program offered good basic skills for large numbers of employees at P&G. One supervisor had data showing that productivity in his department had improved dramatically; it was his belief that this was due, in part, to the training. The company intends to continue its investment in the program and has begun to formulate plans for an advanced skill level curriculum.

## Manufacturers' Perspective

P&G promotes cooperation among employees and strives for a flexible and fully integrated work system. After speaking with the trainees and managers of P&G, we were certain that the curriculum and program has real value in an organization like P&G's. As described earlier, our interviews with area manufacturers, representing a variety of product and process types, confirmed the importance of the Industrial Technology Program curriculum to the manufacturing community generally.

In our interviews, each of the company representatives reviewed the written curriculum and responded to questions about the topic areas that it covered. Both managers and line employees saw the industrial technology curriculum as a positive step towards preparing machine operators for the new responsibilities of more fully integrated work systems. More importantly, each respondent also saw the identified learning objectives of the curriculum as beneficial to their current business operations. Those who were not thinking of restructuring work functions did see great value in having machine operators who could keep their machines running longer before calling on a maintenance mechanic. Although company representatives described the optimal machine operator position in terms specific to their own operations, the following basic functions were attractive to all.

### Troubleshooting/preventive maintenance:

The most useful set of skills for a machine operator to have is the ability to troubleshoot, that is, to be able to identify problems in a machine's operation and to foresee and forestall problems before they occur. Within this skill set, the ability to perform routine maintenance functions—cleaning and lubricating—is considered to be essential.

> ***"Upgrading the technology involved in processing and high-speed packaging really has to involve operators in troubleshooting and repair. The real key is troubleshooting and developing the logical analysis skills to find problems in the equipment."***
>
> **P&G team leader/supervisor**

In reference to troubleshooting, we asked about the types of machine breakdowns that they most often encountered in their companies. Company representatives described relatively uncomplicated problems, like roller or chain adjustments and the jamming of machines by supply build-up, as being the most common reasons for machine downtime. These are problems, they said, that can be avoided if an operator knows what to look for. If the operator sees syrup building up on the line of a candy-making machine, for example, he or she should know that this will result in machine failure and should know how to clean it before the problem occurs. Identifying the need for machine lubrication during a production run, when it is not scheduled to occur until the end of the run, was given as another example of troubleshooting. While supply build-up generally sends the machine out of specification, poor lubrication is often the cause of major breakdowns. According to those interviewed, an operator who can prevent such breakdowns can save the company money and improve productivity levels.

**Job-related technological literacy:**

Once a machine problem or breakdown occurs, interviewees felt that the ability to communicate the type and extent of the problem to the maintenance mechanic is an important skill for an operator to have. The less time a mechanic has to spend identifying the problem, the less time the machine is inoperable. Because many of the companies contacted had only one mechanic on a shift, that mechanic's time is invaluable.

> ***"Getting an accurate description of problems is important; poor communication on what the problems are causes lost time and excess machine downtime. Better operator skills would increase productivity."***
>
> **Comments from the focus group**

If used by machine operators, capacity in both these skill areas can result in less machine downtime and better use of the more highly skilled maintenance mechanic's time. As a manager at a food processing company put it:

> ***"Keep machines running—that's the most important thing. If a machine operator can do that, he's a gold mine for the employer."***

**Flexible Worker Skills:**

Most of the manufacturers with whom we spoke saw the trend towards cross-trained and/or flexible workers as necessary to their survival.

> ***"Our machine operators are learning all of our machines. They are rotated every week so that their knowledge of the equipment is maintained. Now, they have varying degrees of sophistication . . . ideally, we would like them all able to do everything."***
>
> **Manager, food processing company**

The process of restructuring, however, is seen as complex, expensive, and time-consuming. Less than one fifth of the contacted companies have begun the process. Cited as the variables that influence the pace of change in these companies were customer base and customer requirements, industry competition, level of technology used in the manufacturing process, and current workforce composition.

While only three of the nineteen companies contacted had made any significant strides towards upgrading the skill levels of their machine operators, all agreed that future machine operators would have to be more highly skilled. The value of particular skill sets varied from company to company, but there was general agreement that a better understanding of how machines work will be the foundation of skills needed.

**Relevance of the industrial technology curriculum:**

Interview respondents were asked to evaluate the curriculum and its component parts to determine whether it will produce machine operators with the skills that they have identified as important. The responses that we received varied little; the consensus was that the curriculum would lead to the base level of important skills: routine maintenance, lubrication, and identification of defective parts for removal and replacement. Responses about the possible level of troubleshooting skills attainable varied a little through the curriculum. Answers seemed to depend upon the technology used. Interviewees generally agreed that a graduate of this program will be able to prevent many breakdowns through routine maintenance procedures. Also, with this newfound understanding of the component parts of a machine and the interrelationship of those parts, an operator would be able to forestall problems that might otherwise lead to the more complex electro-mechanical breakdowns.

> ***"Our machine operators don't do much maintenance now. As we move forward they will be doing more; that is, the workers will be doing more routine machine maintenance. We need to work this into our union contract, and there is some resistance to that now. But some see it as a good thing to be better trained. . . . [Our Company] will benefit a great deal if workers can check their machines and if they know the whole process. . . . We want to be forewarned if something is about to go wrong."***
>
> **Manager, food processing company**

Beyond these few priority areas, there was less agreement on which skills are needed. Answers ranged from skills that could be attained through training at the level of this curriculum to those that could be acquired in more intensive advanced programs in electro-mechanical technology. Additional skill areas cited by respondents include: fixing line jams, resetting machines to specification, removing simple parts for replacement by a mechanic, removing and replacing simple parts that have broken, repairing simple parts and mechanical breakdowns, and, at the extreme end, repairing simple electrical-mechanical failures, *e.g.*, wire snaps or Programmable Logic Control switches. A more complete outline of suggested enhancements to the curriculum is provided in the following section.

## Next Steps: Employer Views on Expanding the Curriculum and Advanced Competencies

**Expanding the current curriculum:**

Both P&G management and other firm owners expressed consistent themes concerning additional elements or expansion of the curriculum.

> ***"We want to grow and have the workforce help us do things like assess new equipment. . . . We want to get workers involved at the very beginning and get more help from people."***
>
> **Manager, pet products company**

This section describes several recommendations for improvements and expansion of the curriculum and offers a list of advanced competencies that SSVT is considering for inclusion in its Industrial Technology Program. While the injection of basic information in certain of these topic areas can enhance the current curriculum of the SSVT program, it may make more sense to use some of these recommendations to develop new or advanced-level industrial technology programs that can more adequately cover the breadth of knowledge required. The major competency areas raised in our interviews include:

- Troubleshooting
- Problem-solving
- Interrelationship of machine parts and functions
- Quality
- Safety
- Electrical/electronic components of machinery

**Troubleshooting:** Troubleshooting, and proficiency in this area, were topics that came up often. The present curriculum provides the skills needed to perform basic troubleshooting functions, and although these skills may prevent many of the reported types of machine breakdowns, the less frequent, more complicated machine failures would still occur. These more complex breakdowns keep machines inoperable for the longest periods of time and are, understandably, more costly breakdowns to repair, sometimes requiring that outside specialists be called in.

Consistent with comments from P&G managers, other companies recommended that the curriculum include material on a strategy or approach to the handling of machine breakdowns. In many of the interviews, the discussion revolved around the mechanical aptitudes of machine operators and whether troubleshooting is an inherent, intuitive skill. While some of this discussion argues for the development of an integrated academic and applied skill development component to enhance the study of logical analysis and troubleshooting skills, it seems reasonable that students of this curriculum could benefit from a component on the most prevalent types of machine breakdowns, the most prevalent causes of those breakdowns, and strategies for preventing them.

**Problem-solving:** The respondents often referred to the need for skill development in the areas of problem-solving and analysis, primarily with respect to troubleshooting but also as an overall need within their workforces. Along these same lines, and in reference to the impending restructuring of their work systems, interviewees identified a need for their workers to have better communication and teamwork skills. These topics can, and should, be integrated, to a limited extent, into the existing curriculum; however, the significance of these skills to the current trends in industry and industrial jobs warrants that much more attention be paid to injecting these skills into advanced level courses and throughout vocational technical education curricula.

**Interrelationship of machine parts:** If the current curriculum is to be expanded, the company representatives would like to see more emphasis placed on the interrelationship of the various machine components, for example, the relationship of coupling and shaft alignment to the life of a bearing. It was felt that a better understanding of the cause and effect relationships of the various parts of machinery would aid troubleshooting proficiency; however, they were not unanimous on this point. Some company owners indicated that basic skills were more critical and that specifics of equipment operation should be learned either through on-the-job training or in specialized training.

**Quality:** Interviewees suggested that an operational definition of quality is needed, as well as a curriculum component covering the machine operator's role in achieving or maintaining quality production. Much discussion took place on the relationship of analytical/problem-solving skills to quality work, in general, and, again, the importance of teaching these skills to all students. It was suggested that an overview of the standard quality tools might be helpful for students, as might a component on working in teams, as most manufacturing firms that we interviewed are moving to implement quality programs. Because of this movement, an overview may not be sufficient, suggesting the need for a more comprehensive course on quality techniques and tools.

**Safety:** Safety, and the ability of all employees to perform their job duties in a safe way, were certainly of significant concern to most company representatives, although their recommendations for injecting safety skills into the curriculum were not yet clearly thought through. The need for operators to know and understand OSHA regulations was mentioned, along with a basic knowledge of the safe handling of tools and machinery and, in some companies, how to identify and handle hazardous wastes. Overall, the general consensus seemed to be that basic safety and OSHA rules should be covered in this curriculum, while less universal safety issues should be covered in company-specific training.

**Electrical/electronic components of machinery:** Finally, and, perhaps of most immediate importance, all argued that there was a pressing need for operators to understand the electrical and electronic elements of modern manufacturing machinery. Knowledge in this area would not only enhance the operators' troubleshooting capabilities but also enable them to make a greater number of minor adjustments or repairs. Interviewees placed particular emphasis on the companies' need for individuals who understand the technology behind Programmable Logic Controls (PLCs). It would be useful to these companies to have machine operators who could adjust PLCs in their machines, an uncomplicated task that now takes the work of a highly paid mechanic or engineer who understands the relationship of these controls to the production process.

Although most respondents would like to see some coverage of this topic in the industrial technology curriculum, they agreed that the scope of education required goes well beyond the capacity of this program. Company representatives consistently suggested that an advanced course in electronic/electrical/mechanical machine technology be developed.

**Advanced competencies for industrial technology:**

SSVT and P&G are currently planning the next year of their training program, which will include an advanced level curriculum. They are considering a curriculum that incorporates the technical competencies outlined below. SSVT's administration hopes eventually to develop an integrated curriculum for its technology program that includes a number of sub-specialties. This type of enhancement would help increase the efficient use of curricular elements, such as Principles of Technology and applied academic subjects, and would provide logical, focused pathways into specialties.

## Chart III: ADVANCED LEVEL COMPETENCIES FOR INDUSTRIAL TECHNOLOGY

### A. SERVICING PNEUMATIC SYSTEMS

1. Describe the principles of pneumatic systems.
2. Test and maintain pressure regulators.
3. Test and repair air lines.
4. Test and adjust air pumps.
5. Test and replace air gauges.
6. Clean and replace air filters.
7. Test and repair/replace control valves and regulators.
8. Test and repair/replace actuators.
9. Test and replace air cylinders.
10. Conduct preventive maintenance on pneumatic equipment.

### B. SERVICING HYDRAULIC SYSTEMS

1. Describe the hydraulic principle.
2. Test and repair or replace hydraulic lines.
3. Identify and describe hydraulic pumps.
4. Test and replace oil filters.
5. Check and replace oil filters.
6. Identify oil quality and types.
7. Test and replace accumulators.
8. Test and adjust or replace flow controls.
9. Test and repair or replace servo valves.
10. Test and repair or replace directional control valves.
11. Test and adjust or replace pressure control valves.
12. Test and repair or replace hydraulic cylinders.
13. Troubleshoot hydraulic actuators.
14. Perform preventive maintenance on hydraulic systems.

### C. ANALYZING AND SERVICING ELECTRONICS

1. Identify basic safety rules for the use of electrical and electronic equipment.
2. Identify the basics of electricity and magnetism.
3. Investigate and interpret the principles of electric current, voltage, and resistance.
4. Analyze series circuits.
5. Analyze parallel circuits.
6. Analyze series and parallel circuits.
7. Analyze inductive and capacitive circuits.
8. Analyze integrated circuits.
9. Analyze power supplies for electronic equipment.

### D. ANALYZING D.C. CIRCUITS

1. Describe the electron theory.
2. Measure current with an ammeter or multimeter.
3. Describe methods of producing and supplying voltage.
4. Measure D.C. voltage with multimeter.

## E. ANALYZING A.C. CIRCUITS

1. Determine circuit variables.
2. Analyze A.C. Measurements.
3. Analyze capacitor circuits.
4. Analyze inductive circuits.
5. Analyze tuned circuits.
6. Analyze transformers.

## F. SERVICING COMPUTERS

1. Describe computer flow chart naming components and functions .
2. Loan and run available software programs.
3. Change or edit a program using a software manual.
4. Install I/O devices according to the manufacturer's specifications.
5. Troubleshoot malfunctions in computer I/O systems.
6. Run and interpret diagnostic routines.
7. Add options to desk top computer.
8. Prepare a flow chart for a specific sequence of events in performing a given application.
9. Run, edit, or debug PLC programs.
10. Perform preventive maintenance on a PLC machine.

## G. PROGRAMMABLE LOGIC CONTROLLERS

1. Introduction to programmable controllers.
2. Numbering systems and codes.
3. Logic concepts.
4. Programming languages.
5. The control processing unit.
6. The I/O system.
7. Documenting the system.
8. Programming the controller.
9. Programming languages.
10. Insights to application.

## H. MAINTAINING AND REPAIRING ROBOTIC SYSTEMS

1. Identify components of robotics and their applications.
2. Evaluate and adjust (initial start up) installed robotic system.
3. Install end arm tools (effectors).
4. Troubleshoot and repair heat exchangers.
5. Troubleshoot and repair cooling systems.

## I. EVALUATING AND DIAGNOSING ROBOTICS

1. Load test robotic programs.
2. Operate robotic teach mode programs.
3. Run diagnostic routines.
4. Evaluate and diagnose end effectors.
5. Troubleshoot and evaluate robotic vision system.
6. Troubleshoot overload protection device operation.
7. Verify system interlock operation.
8. Troubleshoot air logic systems.
9. Troubleshoot hydraulic systems.

Of principle interest in the advanced curriculum is the integration of more theoretical applications and the linking of the curriculum specifically to state-of-the-art trends in manufacturing, such as PLCs and robotics. Missing is a formal focus on problem-solving techniques, communication skills, and the analytical skills used in troubleshooting.

Based on current conceptions of advanced curriculum, more development clearly needs to be done in this area. Companies are asking for inclusion of communications skills and problem-solving as well as technical skills; vocational schools need to hear what is being asked for and then invest in curriculum development in these areas. As Don Gardner of P&G pointed out, the SSVT/P&G type programs provide "an ideal opportunity to interact with companies to accurately learn what we are looking for. . ." We feel this spirit needs to be carried into higher-order skills as well.

## Organized Labor's Perspectives

The labor officials interviewed—all of them in elected positions—represented manufacturing workers in six companies on the South Shore and included presidents of union locals, a business agent, and a shop steward. The memberships from each of the local unions ranged from less than 40 to 9,000 workers. Often, assessments of the labor force are from the perspective of management only; we wanted to provide a labor perspective as well. Unions can be an important factor in shaping the demand for a skills training program within a company. Because the national and international union administrative offices and education committees of local unions are distributing information on the need for skills training and curricula for educational programs, it is important then to hear what they have to say about skill development.

In general, we found a surprising congruence between the broad views of management and labor officials: labor officials feel that operators should have the opportunity for training in order to become more flexible employees and to broaden their sphere of responsibility. Only one of the union officials interviewed opposed the notion of increasing the training for semi-skilled operators; the rest believed that such training would be beneficial for the membership and for the health of the company.

The latter point is important; the officials whom we interviewed want to maximize the health of the firms where their members work, and they want to do so in the context of what they view as fair. Training figures into their desire because it will increase the productivity of employees and in doing so increase their value to the company. The expectation, then, is that the financial returns on these productivity increases would, in turn, be shared with the workforce.

Labor interviewees described their members as predominantly skilled and highly skilled, and machine operators were considered to be skilled employees. This description differs from that offered by the company managers interviewed, who more often referred to machine operators as low- or semi-skilled.

These interviewee responses about the position of machine operator concentrated on the job descriptions and boundaries imposed by contractual agreements. They also stressed that if training in maintenance skills were made available to line operators (machine operators or assemblers), whether they could use the skills on the job would depend on the negotiation of changes in the contract language.

In three of the interviews that we conducted, a single union represented the workforce. In the two other plants, management had separate bargaining agreements with more than one union. In the single union plants, contract language defining job tasks and responsibilities generally allowed operators to perform such simple maintenance tasks as cleaning, lubricating, and making minor adjustments to their equipment. In the multiple union plants, contract language tended to be more prescriptive to avoid jurisdictional disputes between unions. Interviewees felt that most contract language would allow the addition of a troubleshooting component to the program without significant changes to the contract.

> ***"Management at [my company] is developing a technician concept to replace old job classifications, this means operators will do increasing amounts of repair. . . . We have flexible contract language in this area."***
>
> **IBEW Steward**

In all but one case, union leadership responded positively to questions regarding the upgrading of worker skills, specifically skills that would make workers more flexible and better able to carry out repair and maintenance tasks. They identified training and skill acquisition as benefitting both the members and the productivity of the plant. Increasing machine productivity through reduction in downtime was also viewed as a positive contribution to the health of the company and potential employment of members. Respondents went on to put the value of training in the context of the bargaining agreement. More explicitly, gains in productivity should be shared with the workforce. They also felt that if the tasks and responsibilities of the job were to significantly increase, then the job's relative value and classification should be renegotiated.

Regarding the questions about the training curriculum at SSVT, the responses of labor officials were nearly identical to those of management. They view most competencies in the curriculum as important and feel that additional areas in electrical and electronic skills should be added. They also believe that the curriculum can be useful for both line operators and, as a basic course, for more skilled maintenance mechanics, *i.e.*, the curriculum lends itself to various levels of worker sophistication. Having both line operators and skilled mechanics trained in similar areas and using similar methods would increase their ability to communicate with each other. Generally, the better an operator understands the operation of his or her equipment, the better he or she can assist a line mechanic in identifying and isolating repair problems, thereby, reducing downtime and increasing productivity. These outcomes of a more educated line operator are all viewed as desirable.

In reference to the value of current training available to members, respondents said most companies provide task-specific, on-the-job training. Interviewees felt that this type of training was effective for those job tasks, but that it is not sufficient for the acquisition of new skills in technology applications. In addition, strong basic skills were stressed; the interviewees feel that math skills, language skills, and specific programs in ESL are important to the membership as prerequisites for more advanced skills.

All but one of the interviewees stated that they are proactive in identifying training needs and advocating for training for the membership; yet, none of the unions have the independent ability or resources to initiate skill training programs. In fact, the interviewees claimed credit for spurring management into offering most of the training that is available in their plants.

***"We've approached the company about developing a machine skills program."***

**Business agent**

From the union leadership's perspective, factors of cost and location are important determinants of off-site training programs. All those interviewed felt that if a vocational school could develop a curriculum that met an industrial need, then they would prefer to use that school as a training provider. The reasons for this preference are that traditionally vocational technical schools use hands-on training and that many members are familiar with nearby vocational schools.

Labor leaders concurred that as industries change their organization and technologies, union members will need training in many more nontraditional skills. Curriculum that addresses the improvement of language, math, and technical skills only, will fall short of what is really needed. Because of changing government regulations, curriculum addressing safety in the workplace, hazardous substance handling, waste disposal, and certification requirements should also be integrated into education in the workplace. And, like their counterparts in management, these union officials felt strongly that team building, problem-solving, analytical, and communications skills, as well as others, are necessary if individuals are going to be successful within new work organizations. If training programs are to receive the support and participation from the membership, they must include these skills. As management begins to implement such programs as Total Quality Management (TQM), Just In Time (JIT), Statistical Process Control (SPC) and other productivity improvement programs, the union workforce will need an opportunity to develop the skills necessary to contribute to and participate in changes in these areas.

***"My people need more training on our current equipment; plus, we need training in TQM and SPC and problem-solving. The management wants to do TQM and is working with the us on this."***

**President, IUE local**

In conclusion, union leadership is concerned with the protection of their bargaining agreements but does not see this as an obstacle to productive changes in jobs and work organization. Increased skill levels in the workforce will drive the need for contract language changes that will allow employees to use their skills fully and fairly.

# UNDERSTANDING THE NEED FOR INDUSTRIAL TECHNOLOGY TRAINING

***A Central Finding:***

*Despite the overall decline in manufacturing employment in Massachusetts, there is an intense demand for education/training in industrial technology for the current and future workforce, and market needs dictated by this demand are not currently being met.*

In this section, we review the general demand for industrial technology programs in a vocational education setting. Demand comes from three sources: general opportunities for employment in manufacturing, specific needs of employers for skills developed through education and training, and the flow of younger students into industrial technology careers.

Through reviews of industrial and occupational data, interviews with company managers and labor officials, and a review of the theory and implementation of career awareness programs, a complex picture of the need for industrial technology programs emerges. In some ways, this complexity mirrors the changing nature of manufacturing environments; in others, it reflects the fact that education for manufacturing careers has withered in most vocational education programs. Educators are faced with difficult, but important, tasks in implementing industrial technology programs that respond to trends in manufacturing employment and in designing programs that are also capable of generating a flow of students.

In general, we found the following:

- Despite overall reductions in the manufacturing workforce, there is a modest, albeit very persistent and deeply rooted, demand for manufacturing workers who have skills in newer technologies.
- Due to structural change in manufacturing industries, aggregate statistics of manufacturing occupational growth are misleading indicators of the demand for skilled (trained) workers.
- Because of the current decline in industrial technology programs and manufacturing education, revitalization of and demand for these programs is best accomplished through partnership models and/or customized training programs.
- Career awareness strategies for industrial technology programs need to demonstrate positive aspects of new manufacturing environments and emphasize the broad range of career options available in industry.

## Occupational Demand

Through our work on this report, we have heard a common refrain: there is a modest, consistent demand for technically trained employees in the occupational area and with the skills targeted by the SSVT program. To respond to this demand and to provide the best employment opportunities for students, educators need a reliable way to gauge the strength and focus of that demand. In this section, we address the issue of occupational demand for industrial and machine operator skills.

Justification for the investment of educational dollars and resources in a curriculum is traditionally based on projected employment growth in an occupation or industry. For most occupations, it is relatively safe to assume that increasing absolute employment levels in a particular industry will lead to job placements for program graduates and will, therefore, justify the expenditure of funds to maintain such a program.

For a number of reasons, we feel that this is no longer a safe assumption for manufacturing-related occupations; aggregate demand is an inaccurate and misleading measurement tool for assessing demand for industrial technology educational programs.

There is no question that manufacturing employment is declining in Massachusetts. According to figures from the Bureau of Labor Statistics, Massachusetts experienced a net job loss of just under 200,000 jobs between 1979 and 1991. Historic declines in manufacturing employment and changing trends in the relative mix of technology and labor mean that few occupational areas in manufacturing are experiencing rapid absolute growth. These declines began many years ago, and the most recent recession has accelerated job losses in traditional manufacturing, as well as in Massachusetts' electronics and computer industries.

The following tables provide a picture of the last decade's steady decline in manufacturing employment. Severe job losses in the current recession are deeply felt; economists describe these losses as structural losses with long-lasting implications. Table 1 shows that a smaller proportion of the Massachusetts workforce is employed in manufacturing and that this decline has been accelerated in the current recession.

**Table 1**
**MASSACHUSETTS MANUFACTURING EMPLOYMENT, '79 -'91**

| Year | Manufacturing | Total* | % of Total |
|---|---|---|---|
| 1979 | 672.1 | 2603.5 | 25.8 |
| 1980 | 674.9 | 2652.2 | 25.4 |
| 1982 | 640.1 | 2638.0 | 24.2 |
| 1985 | 654.3 | 2926.0 | 22.3 |
| 1988 | 584.7 | 3126.2 | 18.7 |
| 1990 | 521.3 | 2979.0 | 17.4 |
| 1991 | 484.5 | 2817.0 | 17.2 |

* Non-Agricultural Wage and Salary Employment in thousands.

Source: Center for Labor Market Studies, Northeastern University; Bureau of Labor Statistics, U.S. Department of Labor.

Table 2 provides a somewhat more detailed picture on employment in selected industries as well as some indication of the relative trends in the demand for manufacturing employees in various industries in Massachusetts based on manufacturing employment between 1986 and 1991. Beginning prior to the start of the 1989 recession, it illustrates a sharp decline in employment in most areas of manufacturing and shows the precipitous decline of high technology manufacturing in the category of "electrical and electronic equipment." The increase in the category of "scientific instruments" is due to reclassification. It is abundantly clear that no vocational school should expect to create large, expanded programs based on expectations of a sharply rising demand for new machine operators or manufacturing employees.

**Table 2**
**MANUFACTURING EMPLOYMENT IN SELECTED INDUSTRIES BETWEEN 1986 AND 1991**

| Industry | 1986 Jobs | 1991 Jobs | Rate of Change |
|---|---|---|---|
| Scientific Instruments | 55,100 | 65,900 | 19.6 |
| Printing and Publishing | 54,200 | 49,500 | -8.7 |
| Electrical and Electronic Equipment | 107,400 | 68,300 | -36.4 |
| Chemicals and Allied Products | 17,200 | 17,500 | 1.7 |
| Paper and Allied Products | 24,800 | 21,000 | -15.3 |
| Rubber and Plastics | 29,400 | 21,900 | -25.5 |
| Fabricated Metals | 42,800 | 38,600 | -10.7 |
| Food and Kindred Products | 22,700 | 19,500 | -14.1 |
| Non-electrical Machinery | 107,400 | 76,100 | -29.1 |

Source: Center for Labor Market Studies, Northeastern University; Bureau of Labor Statistics, U.S. Department of Labor

Our interviews with firms in the SSVT service area and our contacts with manufacturing firms confirmed this general decline in absolute levels of manufacturing employment, but also raised important qualifications regarding this picture. For example, P&G is experiencing modest employment growth as it adds new products to its current facilities. At the same time, however, it is introducing new technologies that will increase productivity with the same number of workers on each product line. Another company in our sample, a new, high-volume producer of computer diskettes, is doubling its 300-person workforce due to an expanding market and the consolidation of production capacity. The company is doing more than adding labor, however; it is linking its growth to highly productive, sophisticated production equipment that will garner higher levels of productivity from its workforce.

Within the firms in our sample, only a few were growing at even a modest rate. (Two were experiencing explosive growth.) Several reported that employment was stable or had declined due to the recession. Consequently, most did not report a significant demand for new employees. Two firms reported that their workforces would shrink over the next few years as their firms invested in newer technologies. One of these firms not only reported an explicit policy of workforce reduction through the introduction of new technologies but also an increasing need for workers trained in these new technologies and in machine maintenance. According to their representative, **"We're in the process of downsizing our workforce through introduction of new technologies, but we need more skilled people." The central message here is that aggregate employment statistics ignore important factors that influence the demand for labor. Companies exhibit multi-dimensional responses to the demand for labor that preclude a simple up or down assessment of supply needs.**

Companies in our sample are shedding or adding workers in response to very specific market and sector trends. In addition, changing technology and the organization of work shape a company's need for new workers and for upgrading the skills of the existing workforce. Wide variability exists in the ways that firms approach their use of and demand for labor. No uniform or reliable trends exist, but there is one common theme.

Among all but three of the firms we interviewed, obtaining and maintaining an adequately skilled workforce was among their top priorities. This surprisingly common view reflects the restructuring of manufacturing and their responses to competitive pressures. For example, one of the plant managers that we interviewed told us that his new parent corporation had instructed him to make training and capital investments his top priorities for 1993 and wanted to bring the subsidiary in line with its worldwide policies. Team building, problem-solving, as well as technical skills were to be included in the training. **"We are operating with outdated equipment and with an outdated workforce," this plant manager told us. "Upgrading will include both new technology and training in how to work with the equipment and work in teams."**

Several other firms in our sample were making organizational and process changes to enhance product quality and increase productivity. And, they are incorporating advancements in manufacturing technology, as well as different, more participatory, styles of work organization. While we can hope the impact of these efforts may, over the long run, stabilize and increase general manufacturing employment, the more immediate short-term impact is a higher demand for:

- Relatively few members of a technically trained, entry-level workforce.
- Sources of training curricula for new manufacturing environments.
- A far more intense demand for training of the existing workforce.

There is a modest demand for a supply of workers to operate increasingly sophisticated processing equipment, as well as for a more technically trained worker/technician who can perform a broader range of functions than those of the traditionally defined, semi-skilled machine operators.

In addition, among a small but growing number of firms and certainly among some of the firms in our sample, there is a demand for workers who can make contributions to high-performance workplaces. This ability requires "high value-added skills development" that goes beyond technical skills training alone. Most firms in our sample stated that they were looking for workers with problem-solving skills and workers who understood the basics of quality process systems.

Can this demand be quantified or projected over the next few years? Not with conventional aggregate statistics; however, we feel that partnerships offer an effective way to assess demand.

The program developed at SSVT is an example of responding to an expressed demand by one company for workers with the skills that we have just described. Our interviews with a sample of additional companies and with representatives of organized labor also indicated that this demand exists in other companies and other industries. It is our strong view that this demand can best be determined on a micro-level—as opposed to a macro or aggregate statistical level—through partnerships between the schools and target firms, in collaborative arrangements such as that between P&G and SSVT, or among a consortium of firms in a target industry.

School committees and administrators will not authorize expenditures of funds to implement or maintain an industrial technology program on the assumption that there is a demand out there somewhere. Partnerships are concrete expressions of the demand for a supply of skills and the ability of an educational institution to supply those skills either to students in an educational program or through post-secondary education/training programs. While considerable organizational work needs to be done to create and develop partnerships, they are a far more accurate and effective determinant of the demand for occupational skills. As described in detail earlier in this report, the partnership with P&G has enabled SSVT to:

- Gain specific information on industry trends and training needs.
- Gain access to current manufacturing equipment and work environments.
- Refine the faculty's and the administration's ability to integrate an industry relevant curriculum with an existing vocational program.
- Assess more accurately the expected volume and facilities capacity required for industrial education.

**Transferability of manufacturing skills and career development:**

The SSVT/P&G program focused on the operation of packaging machinery, particularly for the food and consumer products industry. Many elements of the curriculum, however, apply to the fairly broad occupational category of machine operator and can apply to a variety of manufacturing industries. For example, the sample of manufacturers with whom we reviewed the program included metal stamping and pharmaceutical companies, as well as firms in the food and consumer product packaging industry. Even though these firms produced a wide variety of products, ranging from nearly a continuous-process orientation in the pharmaceutical industry to the high-volume, discrete production of durable goods, they shared a dependence on machine operators doing relatively repetitive operations on a relatively narrow range of types of equipment.

Thus, it is our assessment that (1) the analysis of occupational demand for an industrial technology program such as SSVT's should encompass a fairly broad range of manufacturing firms and industries, and (2) the basic curriculum develops transferable skills across a number of industries.

Descriptions of machine operator occupations in the Dictionary of Occupational Titles are similar in that they include positioning material, monitoring operations, and carrying out secondary tasks across various industries. They also include similar physical activities and levels of responsibility with regard to tasks and decision-making.

Such similarities continue across several manufacturing sectors. A partial list of the industries for which SSVT's curriculum would apply include:

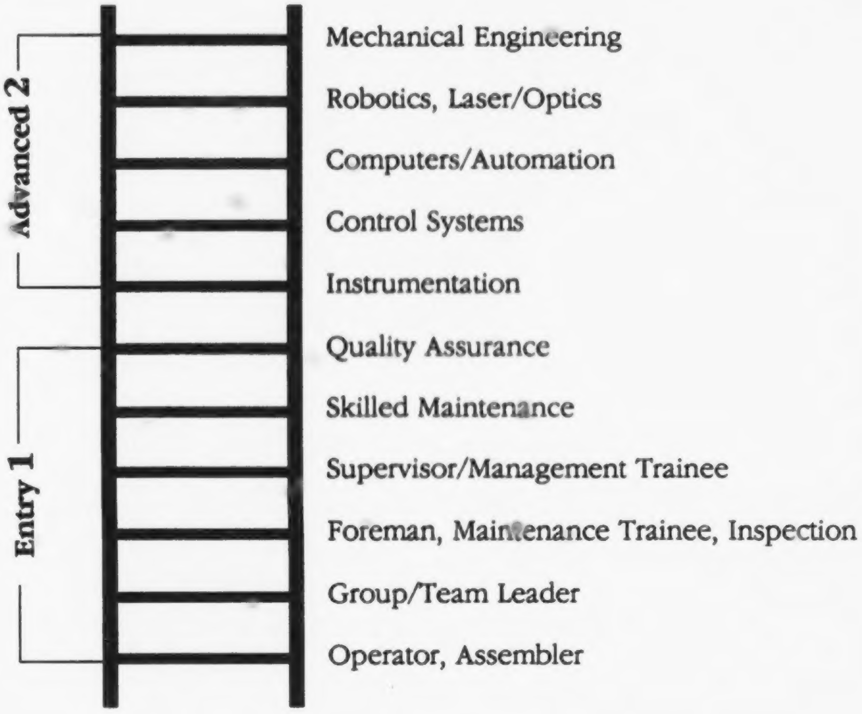
- PLASTICS
- PAPER
- PRINTING
- STAMPING
- ELECTRONICS
- FOOD PROCESSING
- BINDING
- CHEMICAL PRODUCTION AND PROCESSING

**Career ladders and development:**

An aspect related to the occupational demand for the skills developed in the SSVT program is the potential for career development and movement into related manufacturing occupations. Although the same growth conditions exist for manufacturing occupations, in general, career paths for those employees with better skills and with educational credentials are far superior to those for employees who lack educational credentials and advanced skills. Those entering machine operator positions with a solid skill foundation can also enter the paths toward supervisory, maintenance mechanics, technician, quality assurance, advanced technical, engineering, and management positions, many of which require additional technical education and degrees from a community college, technical institute, or four-year college. In all our interviews, respondents discussed the potential for advancement of machine operators who possessed high levels of skill and aptitude. At P&G, this potential for advancement is especially true because nearly all hiring of technical workers and management comes from within, based on skill demonstrations and educational achievement.

Chart IV defines the career ladders for workers in a typical manufacturing plant in our sample (through level 1) and includes the more advanced rungs (level 2, as defined by the Center for Occupational Research and Development [CORD]) that could be attained through additional training or through tech prep programs in industrial technology.

**Chart IV: CAREER LADDER IN MACHINE OPERATION AND MACHINE TECHNOLOGY**


Advanced 2
Entry 1
Mechanical Engineering
Robotics, Laser/Optics
Computers/Automation
Control Systems
Instrumentation
Quality Assurance
Skilled Maintenance
Supervisor/Management Trainee
Foreman, Maintenance Trainee, Inspection
Group/Team Leader
Operator, Assembler

Source: Sample Interviews (1); Daniel Hull, President of CORD, Presentation, December 9, 1991, Washington, D.C. (2)

Not included in this chart is a second and equally important constellation of occupationally related skills—the problem-solving and communication skills that provide the base for new forms of work organization and the applications of total quality management systems. Problem-solving and communication skills, once required of management and upper-level technical professionals only, are now being required of those in the lower levels of traditional occupational hierarchies. In some cases, new positions are created to reflect changes in occupational structures. In P&G for example, the position of team leader did not exist several years ago, and they have invested considerable resources to train those new leaders, off-site and on-site. Again, it is important to note that changes such as these in occupational structures and job classifications do not appear in standard arrays of occupational data.

Chart V captures some of the demand for non-occupational specific skills as they relate to career development. These were described by management or workers in the firms that we interviewed and drawn from CORD analyses of technician skill sets that apply to higher-level, manufacturing technician occupations. The necessity of these skills as competencies required for movement through a career ladder varies by firm and by the degree to which a firm has changed its traditional job and hierarchy definitions.

**Chart V: NON–OCCUPATIONAL SPECIFIC SKILLS RELATED TO CAREER DEVELOPMENT**

- Analyze, troubleshoot, and repair systems composed of subsystems in three or more of the following areas: electronic, electrical, mechanical, thermal, hydraulic/pneumatic, optical.
- Use materials processes, apparatus, procedures, equipment, methods, and techniques common to a generic technology.
- Use statistical and analytical methods as problem-solving tools; an understanding of mathematics including computer language and higher- level mathematics may be required.
- Use techniques and concepts of interpersonal communication designed to elicit and support communication within and between levels of the workplace.
- Use computers for information management, equipment and process control, and design.
- Apply detailed knowledge in one field of specialization with an understanding of applications and industrial processes in that field.
- Apply principles of industrial processes across processes in related technologies.
- Record, analyze, interpret, synthesize, and transmit facts and ideas with objectivity and communicate information effectively by oral, written, and graphic means.

Finally, manufacturers report that there is a need for a trained manufacturing workforce simply to replace workers who are older and retiring. The average machinist, for example, is fifty-eight years old. Over the next ten years, then, we can predict that a steady number of manufacturing jobs will become available as a result of retirement and other age-related attrition.

Clearly, it is important that the capacity to prepare future workers for these positions continues to exist. Today, the vocational education system has an opportunity to assist manufacturing companies in preparing the current manufacturing workforce to participate in competitive work systems. If schools can capitalize on this opportunity, they will be able to sustain and improve their manufacturing-related programs now to enable them to meet the longer term workforce development needs of Massachusetts' manufacturing sector.

At a recent briefing for the Massachusetts Employment and Training community about the telecommunications industry, **Larry Wolfman** of Bytex Corporation talked about the need for manufacturing personnel in high technology-related industries. He said, **"While there are currently enough skilled individuals to fill current needs, manufacturing is becoming a lost art in Massachusetts. It is dying out. If we have this meeting three years from now, we will be talking about a critical labor shortage."**

Comparatively, the modest demand for well trained, new hires in manufacturing is dwarfed by the need for training and skill development in the existing workforce. While industry spends a great deal on training (some estimate as high as $38 billion annually), most is spent on management and higher level technical training. Many firms are beginning to realize that they must also invest in skill development for production workers if they are to become high quality, more competitive organizations. The next section addresses the perceptions of management regarding the training needs of the existing and future workforce and the ways that vocational education might meet some of these needs.

## Company Training Practices, Views, and Needs

In order to further examine the need and demand for customized training and the perceptions and requirements of companies who are the potential customers for this training by vocational education schools, we asked our fourteen company interviewees a variety of questions regarding their current training practices, training vendors, and training needs. The following is a summary of their responses.

### Current training practices:

Most of the companies in our sample have no formal training programs. At the same time, virtually all of these firms agreed that it would be better to have line operators who are more knowledgeable and flexible with regard to machine/line operations and the process as a whole. For these companies, better trained line operators are critical to their competitiveness and long-term viability. As the manager of an electronic component manufacturing company said, **"Because of vendor qualification requirements, we need to demonstrate and to implement a more integrated approach to high quality and productivity. . . .This means operators have to take more responsibility."**

A few of these companies have begun to wrestle with the development of cross-training and of programs designed to increase flexibility, quality, and productivity and are finding that the primary issues are time and resources. Limited financial resources and planning time, as well as strict production schedules, prevent these companies from developing and implementing adequate in-house training programs.

As it stands today, the vast majority of company training is on-the-job and task specific, and typically, in-house employees perform this training. Equipment vendors often provide training on the use of new equipment, and outside consultants are usually brought in to provide safety programs. Companies typically use consultants and in-house employees to train their staff on quality, productivity, computer controls, and cross-equipment operation. (See Chart VI.) The vast majority of training related to operations (operators/mechanics), when it occurs, is conducted on-site, and these companies rarely used educational institutions to provide training.

**Chart VI: CURRENT TRAINING PRACTICES**

| Training Provided | Usual Provider |
|---|---|
| • On-the-job/task specific | • Company employees |
| • New equipment use | • Equipment vendors<br>• Manufacturers |
| • Safety | • Consultants<br>• Company employees |
| • Additional training (*e.g.*, quality, productivity, computer controls, cross-equipment operation) | • Consultants<br>• Company employees |

Virtually all of the sample companies offer tuition reimbursement programs for management and supervisory personnel, and many offer company-wide tuition reimbursement programs. These programs are usually restricted to job-related courses, and in some cases, reimbursement is dependent upon the student receiving a satisfactory grade, as defined by the company. The extent to which this type of training is encouraged and taken advantage of fluctuates a great deal. A few companies seem to actively encourage workers to take advantage of this opportunity, whereas others do not actively promote these programs, and they are little used.

It was quite evident that most of the companies sampled felt that their current training efforts were not meeting their company needs. These interviewees also felt that they need to do more but that they do not have the time or the expertise to deal with this issue adequately.

The need for more training usually comes down to a single larger issue—competitiveness—with productivity, quality, and timeliness as the necessary ingredients. As one manager said, **"Our plant operates continuously. . .anything we can do to reduce downtime, keep production going, and increase productivity is a good investment."** Whether the company is trying to develop Continuous Improvement Employee Involvement, to increase quality standards, or just to lower machine downtime, training is key. Those companies who are highly successful are just as concerned about training as those that are merely surviving. They all know that to remain successful they need to make strides in these areas through higher work performance—directly related to training.

### Factors in choosing training programs:

We explored the factors that companies believe are most important *vis a vis* training in order to determine what vocational education institutions should consider as they develop training programs. As shown in Chart VII, the most important factors for companies choosing a training program go hand in hand—quality and value (cost benefit). Cost is not the main issue. Although most companies have cost constraints, the most important issue is that the training pay for itself, hopefully many times over, through increased productivity and quality. In the words of a manager in a food processing company, ***"We have no hard and fast rules on the cost of training. . . . If the training will pay for itself with greater productivity, then fine. . .we will pay what it costs."***

Next, in importance, is location and scheduling flexibility. Training must be near the manufacturing plant, and the class schedule must be such that shift and production schedules can be accommodated to the greatest extent possible. Companies have to be able to keep to production schedules, as well as keep costs for overtime and replacement workers to a minimum. Most companies said that they have and would continue to pay for release time for training. On-site training was seen as extremely time efficient; however, several saw it as potentially difficult because workers tend to be called back to work when minor crises occur. Offering both day and evening classes with the option of creating a schedule that fits the company's needs is optimal.

**Chart VII: FACTORS IN CHOOSING TRAINING PROGRAMS LISTED IN ORDER OF IMPORTANCE**

- Quality/value (cost benefit)
- Location—near the manufacturing plant
- Scheduling flexibility
- Program design—broad skills, job related, theory/hands-on mix
- Provider—good reputation
- Cost

Companies also want training that adheres to two major principles: (1) Workers must develop more global, broadly applicable skills. The training should be related to the job but not to one machine or specific operation that would make the training quickly obsolete. (2) Training must combine theory with a hands-on approach. Although most companies have preferences regarding the design of the training programs, they usually do not have the time to be involved in the designing process from scratch. They can only help with the fine tuning or customizing effort. Some balance will have to be reached in this regard because the investment of planning and design time on the part of both partners is critical to the success of a training program, as was shown in the SSVT program.

**Company experience with and views of vocational technical schools:**

Based on company responses, vocational schools have a real opportunity to develop a new customer base and market for their services—the customized training market. Several of the companies interviewed have had previous experience with vocational technical schools, some with SSVT specifically. These companies have hired vocational technical school graduates (although two of the companies mentioned that they were not able to hire or keep these graduates because they lean toward higher paying jobs than these smaller companies can offer), have been involved with their cooperative work-study programs, or have had workers take courses at these schools. Their experiences seemed to have been positive; the companies felt that the graduates received a good, broad education and became valuable employees. One of the interviewees had attended a vocational technical school and said that he felt he got a good all-around education, as well as a skill, but that he felt that these schools were often behind the times on technology and equipment. Developing training partnership programs such as SSVT's with P&G is one way for vocational technical schools to help ensure that they remain more current *vis a vis* technology and equipment.

Roughly one half of the interviewees had not had any experience with these schools in the past. Yet, despite this, all of the respondents, when asked whether they would consider using a vocational technical school for training in the future, uniformly answered yes. A few of the interviewees felt that because colleges, universities, and institutes are geared more toward teaching white collar workers, they often are too theoretical in their approach to be providers of company-sponsored training for operations employees. In contrast to those perceptions, companies without experience with vocational technical schools were open to and/or positive about the prospect of working with these schools. These companies who have had experience felt favorably and thought they were a natural choice for training given their greater emphasis on a combined theoretical and hands-on approach.

**Need for training:**

The need and opportunity for training programs/partnerships between manufacturers and vocational technical schools exists. This solid market opportunity is evidenced by the fact that virtually all of the company respondents, small and large alike, indicated a need for training in order to remain competitive as well as a positive view of vocational technical schools as providers of that training. This market is not an easy one to access and develop given the time constraints and varying requirements of manufacturers. Vocational technical schools will have to spend a considerable amount of time developing relationships with these firms as well as training opportunities. Schools will also need to develop flexible approaches to providing training in order to meet each customer's set of requirements.

Virtually all of the companies said that they could use training at the basic and/or more advanced levels for their existing workforce. Several companies mentioned the need for workers to have a better sense of the manufacturing process as a whole, including its relationship to business operations and customer satisfaction, and to learn the skills to foster greater worker flexibility and productivity, such as basic math, communications, and analytical and problem-solving skills. As has been mentioned before, several of the companies mentioned that they needed ESL classes because they were wrestling daily with language problems.

With regard to the future, these manufacturing companies felt that manufacturing in Massachusetts is in trouble and that one of the things they need is an employee pool that is better trained and more interested in manufacturing. They felt that many students coming out of vocational technical and other high schools do not have a realistic picture of what today's manufacturing environment looks like, that these students have a negative view of manufacturing and the opportunities it offers.

> ***"We have to make manufacturing education attractive again. . . . We have to get students going into schools because people are not qualified to work in modern manufacturing shops; vocational schools need to recruit and attract better students into manufacturing. Manufacturing has changed."***
>
> **Manager, metal-forming company**

Respondents suggested three ways that schools could encourage students to consider manufacturing as a career:

- Broader adoption of tech prep and co-op programs.
- Exploration/use of German apprenticeship model.
- Career/job fairs that companies could attend.

These companies do not guarantee that there will be many manufacturing jobs, but rather that in the future, replacement and new jobs will require greater skills as companies become more competitive through technology/productivity gains.

From our survey, we learned that companies are looking for graduates who are interested in and understand the manufacturing process and production methods and who have a basic knowledge of mechanical, hydraulic, air, electric, electronic, and computer systems. Basic academic and applied training including math, communications, analytical, and problem-solving skills are also critical. With a strong knowledge base, employees can be trained on specific production equipment and processes and prepare to fill more flexible, broadly-defined jobs within changing work structures.

## Career Awareness Programs

**Middle/junior high school career awareness programs:**

An important part of this market discussion, as indicated by the individuals in our interview sample, is demand and creating demand for vocational education/industrial technology education. Career awareness is a critical step in developing interest in and recruiting students for vocational/industrial technology education.

A few reasons make this necessary. First, vocational education programs traditionally have had to struggle to overcome the negative cultural stereotype that they are designed for those students who have the least potential for academic success. In many cases, vocational education is regarded as the "dumping ground" for students who do not fit the classic profile of the "successful student"—the college-bound student. Such stereotypes inhibit students from engaging in unbiased explorations of their occupational interests and preferences, interests and preferences that might lead to useful and successful careers via vocational education. And, with their enrollments declining, vocational technical schools must ensure that they attract *all* students for whom vocational education is appropriate.

Further, middle and junior high curricula such as Industrial Arts, Industrial Technology, and the newer, more comprehensive curriculum called Technology Education, have traditionally exposed students to industrial arts (woodworking, metalworking, and drafting) and technology—the development of, applications to, and impact on our society and environment. After years of severe budget cuts, both at the state and local levels, most middle and junior high schools are now not able to offer these courses, and, therefore, students do not get exposed to classes/material that might lead them to explore related industrial careers.

Finally, as has been discussed, jobs and job training needs in the industrial world are changing. Students need to know that the industrial world and the jobs therein are not the same as in the early- and mid-1900s and that possibilities for higher skilled, more flexible jobs exist. Students also need to know what training is required to be fully prepared for a productive role in industry today.

In order to overcome the traditional stereotypes and provide students with opportunities to explore occupations that require vocational technical education and to choose vocational technical education, vocational schools must develop and implement aggressive strategies for students' career development at the middle or junior high school level. Partnerships should be developed to support these strategies.

When we spoke to a number of vocational educators in Massachusetts and other states about successful career awareness programs that they currently have or have tried, we came across an innovative program called Project Freedom at Shawsheen Valley Regional Vocational Technical High School in Billerica, Massachusetts. Project Freedom, a program for middle school students, embodies the elements found to be most effective in helping young students make educated decisions about future career opportunities. We have extracted key elements from Shawsheen's Project Freedom and from other model programs to compile the following set of recommendations for SSVT and other providers of industrial technology education programs:

1. **Orientation to industrial technology program offerings for students, parents, teachers, and guidance counselors in the middle/junior high school:** An orientation should comprise structured activities designed to help participants identify and explore their biases regarding vocational education and industrial technology, as well as information about numbers and types of relevant jobs available, potential income levels and career ladders, and information regarding academic skills required. First-hand experiences of workers in these occupations should be provided.
   - Career or job fairs can afford students, parents, and school professionals the opportunity to meet with industry representatives (management and staff).
   - Industry representatives have the chance to talk about employment opportunities in their field, and attendees have the opportunity to ask questions regarding opportunities and necessary skills. Several company representatives that we surveyed said they would welcome the opportunity to participate in career/job fairs.
2. **Classes and labs in industrial technology program offerings for parents, teachers, and guidance counselors in the middle/junior high school:** Participants should experience the same types of learning activities that their children or students would pursue. For example, in a Principles of Technology class, participants might measure and test the effects of thermal insulation, or in a basic mechanics class, participants might replace gears, lubricate bearings, or disassemble a pump.
3. **Career exploration classes and labs for middle/junior high school students, including content similar to the content provided for parents, teachers, and guidance counselors:** In addition to acquiring information about industrial technology occupations and career ladders, it is important that students have opportunities to explore their own likes and dislikes with regard to hands-on occupational work through doing actual course tasks. Students also should be provided with information regarding the courses that they need to take in high school and the relevant middle school preparation necessary to fulfill the requirements of an industrial technology program.
4. **Promotion of as well as follow-up to orientation sessions, job/career fairs, classes and labs, and any other activities:** Vocational technical schools can use direct mail letters, flyers, posters, newspaper ads, and phone contacts to communicate with school professionals, parents, and students to promote activities and programs. Promotional materials can also be used as

stand-alone pieces to help get the vocational/industrial technology education message across to the target market.

5. **Evaluation of program processes and outcomes:** Representatives of those groups participating in the career awareness program—including parents, teachers, guidance counselors, students, and industry representatives—should be involved in monitoring the results of the program as it is implemented. In order to realize the maximum "marketing benefit" of their career awareness programs, vocational technical school administrators will need to be prepared to respond to participants' concerns and suggestions.

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## *PRINCIPLES OF TECHNOLOGY*

*Principles of Technology is a two-year course in applied science that provides students with an understanding of the principles of technology and the mathematics associated with them. The course is designed to more effectively prepare high school students for technical careers. It is both academically rigorous and practical, with task-oriented application and illustration of principles of science. SSVT and approximately 15% of Massachusetts' high schools (both comprehensive and vocational) are now offering this course. This curriculum has been adopted more widely in other parts of the country.*

*Principles of Technology can also be used as an effective tool in a career awareness strategy. With the void in applied technology/science courses in middle and junior high schools, there is very little exposure to material that is hands-on and applies to the world of work. By exposing science, technology, and math teachers and guidance counselors to this curriculum, it will:*

- *Demonstrate to teachers, and ultimately to students, how academic and applied material can and should go hand-in-hand.*
- *Inform teachers and counselors as to what is being taught in the vocational technical schools making them more knowledgeable and helpful to students in their decision-making processes.*

*Principles of Technology materials can also be used in recruitment fairs/classes and labs for students, their parents, and school professionals as mentioned above.*

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The proposed career awareness program in industrial technology is a critical step in implementing a dynamic marketing program to attract middle/junior high and high school students to industrial technology. The program would reach not only students and their peers but also parents, teachers, guidance counselors, and educational administrators whose perceptions of vocational education and industrial technology have a direct impact on the demand for such programs and on the viability of SSVT and other vocational technical schools as educational institutions.

**Post-secondary linkages and career awareness:**

Recently, increasing attention has been directed in Massachusetts and elsewhere to linkages between high school programs and post-secondary education *e.g.*, associate degree programs or four-year degree programs. Generally termed 2+2 or 2+4 programs, they are designed for students who do not choose to enter a four-year college program upon completion of high school. Post-secondary programs offer students, including adult students returning to an educational program, the opportunity to gain what has been called "advanced mastery" in an occupational or skill area.

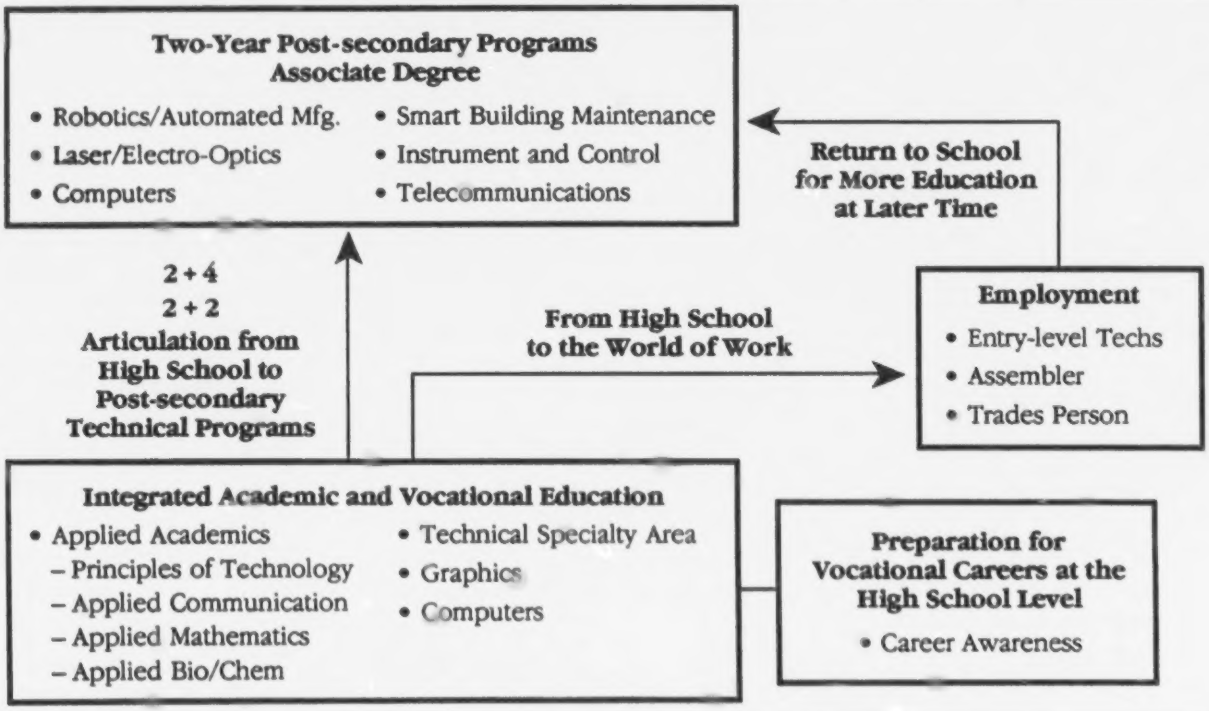
For students completing high school, planning for entry into a post-secondary, advanced mastery program would begin in the junior year and would prepare the student for certification in a technical or professional competency. The certification would then be recognized by the post-secondary institution.

Two + two programs, originally a Western European approach to technical training, and discussions of programs in advanced mastery recognize that just over 70% of high school graduates or high school students do not pursue a baccalaureate degree and that no well-defined pathway provides high school students with advanced technical training. Two + two and two + four programs offer a way to provide students with a structured link between high school and college that provides integrated academic and occupational training.

An especially strong need for such linkages exists in manufacturing technologies. Thirty years ago, a manufacturing apprenticeship system took the place of an articulated educational program. By combining on-the-job learning with rigorous classroom training, apprenticeship offered young workers leaving high school an opportunity to gain valuable higher-level technical skills. With the decline of apprenticeship (in Massachusetts, 95% of all apprentices are in the building trades), there is no commonly recognized method for manufacturing workers to develop advanced skills in manufacturing technologies.

The following chart, adapted from Center for Occupational Research and Development material, provides an illustration of the relationship between industrial technology programs in vocational high schools and post-secondary industrial technology education. The arrows describe two paths for entry into a post-secondary program from school and from an occupation.

**Chart VIII: LINKAGES TO POST-SECONDARY INDUSTRIAL TECHNOLOGY EDUCATION**


Two-Year Post-secondary Programs
Associate Degree
• Robotics/Automated Mfg.
• Laser/Electro-Optics
• Computers
• Smart Building Maintenance
• Instrument and Control
• Telecommunications
Return to School for More Education at Later Time
2 + 4
2 + 2
Articulation from High School to Post-secondary Technical Programs
From High School to the World of Work
Employment
• Entry-level Techs
• Assembler
• Trades Person
Integrated Academic and Vocational Education
• Applied Academics
– Principles of Technology
– Applied Communication
– Applied Mathematics
– Applied Bio/Chem
• Technical Specialty Area
• Graphics
• Computers
Preparation for Vocational Careers at the High School Level
• Career Awareness

Assuming the existence of articulation agreements between vocational high schools and post-secondary institutions, it falls to the high school to help students become aware of these options and to assist in designing the appropriate course of study for their chosen career paths.

Partnerships, such as the one between SSVT and P&G, can play an important role in promoting career awareness and informing students of career opportunities. P&G, for example, has a well-developed career path structure that depends upon the acquisition and demonstration of competencies. In addition, the company is a manufacturing firm that uses advanced technology in its production processes, process control systems, and monitoring systems. By making these resources available to students through the partnership, SSVT can expose students to employees and modern manufacturing methods, putting the students in a better position to understand career options in manufacturing and the need for advanced technical training.

In addition, such a partnership enables school faculty to remain current regarding new technologies used in manufacturing and helps them understand, like the students, the necessity for advanced training. Again, using the P&G example, faculty from SSVT were able to tour the production facility and gain firsthand knowledge of new technologies and what skills were needed. Extending SSVT's partnerships to other firms and industries would mean broadening this exposure.

Simple exposure to and exchange of information, however, are not enough to fully institutionalize linkages to post-secondary educational institutions. Parents and students must be educated in the career opportunities available in industrial technologies and made aware of what institutions offer "advanced mastery degrees" or their equivalents. To provide this education, schools could employ some of the suggested elements of the middle/junior high school career awareness program to develop post-secondary awareness.

# TRENDS IN VOCATIONAL EDUCATION: HOW PARTNERSHIPS FIT IN

***A Central Finding:***

***Creating greater links between education and the workplace is a trend that benefits both educational institutions and manufacturing and drives other positive trends in the manufacturing community.***

This section describes many of the major trends that are changing the face of vocational education in Massachusetts and the nation. As one would suspect, the rate of change varies greatly from state to state and school district to school district, but nevertheless, vocational education is changing. A closer relationship between the workplace and the classroom, industry partnerships, newly designed articulation agreements, and greater integration of academic and applied learning are just some of the examples of these trends. (To enable further research in this area, Appendix C provides a literature search that includes documents related to trends in vocational education.)

## Integration of Academic and Vocational Education

Nationally and in Massachusetts, a variety of models and efforts focus on the integration of academic and vocational education. The National Center for Research in Vocational Education has identified eight distinct models in a hierarchy based on the extent of integration. At one end, efforts link, but do not integrate, academic and vocational programs. These efforts range from relatively modest ones to increase remedial education within an existing vocational course to more substantial ones to increase the interaction between academic and vocational settings and learning vocabularies. Some schools now offer "career paths" in occupational clusters in which teachers and students are grouped around a series of academic and vocational courses targeted to an occupational area. (Grubb, 1991)

On a national level, the Carl Perkins Vocational and Applied Technology Act of 1990 requires vocational education to be provided in a "coherent series of courses." The Act argues against simply adding another new course in, for example, problem-solving, to a traditional program. "What Work Requires of Schools," the first SCANS (Secretary's Commission on Achieving Necessary Skills) report, categorizes the goals of an integrated curriculum into three foundation skills (basic skills, thinking skills, and personal skills) and five competencies (resources, interpersonal, information, systems, and technology). The Commission proposes that curriculum be organized to develop the interplay of these foundation skills and competencies in ways that parallel this interplay in current and anticipated work environments (SCANS, 1991).

This integration gives students a wider array of career options than the traditional educational tracks. In the more traditional approach, vocational graduates were expected to enter a trade or a job without additional education, while college prep graduates were only prepared to go directly to college, not to a job. Now, several exemplary school programs focus on an industry or a closely related set of occupations and then offer a single track of courses in that area. On completion of these courses, students may go to a four-year college, community college, or technical institute, or they can go directly to work. (Benson, 1991) This model is commonly referred to as "tech prep."

### Tech prep programs:

Funded by the Perkins legislation, tech prep programs provide an alternative to college prep programs. Tech prep is typically a four-year sequence of study that begins in the eleventh grade and continues through two years of post-secondary occupational education, culminating in an associate degree or a certificate. Tech prep programs are designed to support the articulation of vocational education programs between secondary and post-secondary institutions. The law requires that these programs begin with a consortium of representatives of local education agencies, including intermediate educational agencies, area vocational schools, and institutions of higher education that offer two-year associate degrees or certificates—community colleges, technical institutes, and proprietary trade schools.

According to the Office of Vocational and Adult Education in the U.S. Department of Education, tech prep programs must have the following seven elements:

- An articulation agreement between consortium participants.
- A 2+2 design with a common core of proficiency in math, science, communication and technology.
- A specifically developed tech prep curriculum appropriate to the needs of

consortium participants.
- Joint in-service training of secondary and post-secondary instructors to effectively implement the tech prep curriculum.
- Training programs for secondary and post-secondary counselors to recruit students and to ensure program completion and subsequent appropriate employment.
- Equal access of special populations to the full range of tech prep programs.
- Preparatory services such as recruitment, career and personal counseling, and occupational assessment.

The tech prep initiatives, outlined in the new Perkins Act, have fostered numerous and somewhat varied efforts in Massachusetts. The Department of Education reports that about 170 agreements between secondary vocational and post-secondary programs are in place and thirteen consortia, centered on articulation agreements, have been funded (1992). Included are programs in industrial technologies, such leading edge technologies as biotechnology and electronics, and such service industries as health. Others are under development. The aim in Massachusetts is eventually to include every vocational program curriculum and every school in some articulation agreement.

**Integration of academic and applied learning:**

Integration of academic and applied learning within course curricula is another aspect of the trend toward greater integration that has far-reaching consequences. By integrating the theory and the applied learning, students learn the theory through the application of principles via task-oriented demonstration and illustration. This integrated method is particularly helpful for students who have learning styles different from the norm and for whom abstract principles are not sufficient to achieve understanding. Applied learning also promotes critical thinking and problem-solving and, to a certain extent, working as a team all of which are needed in today's workplace. In Massachusetts, integrated programs are being developed in areas such as Applied Technology (Principles of Technology and Technology Education are examples), Applied Communications, Applied Mathematics, and Applied Science (*e.g.*, biology and chemistry).

Integration involves a considerable amount of planning, faculty development, and materials development. A frequently heard comment from teachers and administrators involved in these programs is that the theory of integration is outpacing the materials, both in quality and quantity. Additional materials must be developed that demonstrate integrated concepts and use the language of integration.

## Vocational Education Link with the Workplace

As we have discussed, the Industrial Technology Program at SSVT was in part conceived to meet new skill and knowledge requirements posed by a changing industrial environment. In this sense, the program can be placed within national vocational education trends that seek to develop programs that reflect changes occurring in the workplace.

A central theme of vocational education reform is exploring ways of "bringing school and work closer together—to enhance the workplace as a learning site and to make school learning more relevant to the problem-solving and social skills students require on the job." (Bailey, 1990) We view the partnership between SSVT and P&G as an important step in this direction. Currently, the program affects the employees of P&G most directly, but it also affords the high school students the opportunity to learn from the program curriculum and to work in relatively close proximity to the P&G trainees. The potential for integration into the regular high school program, however, gives an important example of how a school can respond to industry and can use these ties to improve educational opportunities for its students.

## Impact of Workplace Changes on Education and Training Needs

Today's manufacturing employee must be well-trained and capable of responding quickly to design, engineering, and product changes. Rapidly evolving production and process technologies in industry, in particular the applications of microelectronic controls, are changing the skill requirements of the shop-floor workforce. In addition, the response of U.S. manufacturers to global competition means that changes in product styles and characteristics are more frequent. Companies can no longer rely on long-run, highly standardized production processes, and, like P&G, many firms are changing the structure and operations of their organizations in order to keep pace with these trends and maintain or expand their market position.

Modifications in organization structure and operations are changing the ways that we view labor and the organization of labor skills and are having important implications for education. In particular, developing ways to help both current workers and new labor entrants understand and keep abreast of workplace technologies and designing effective ways to learn problem-solving and analytical skills are two educational challenges.

Published articles on the challenges facing American industry and our sample of interviews with industrial employers and union representatives both confirm that employers are seeking workers who can exercise a greater degree of judgement and a higher level of participation in the productive operation of the plant. Although they expressed this opinion in varying ways, employers are seeking workers who are technically skilled and "literate," which broadly means able to think and communicate well. Educational reformers and professionals translate this literacy into the need for integration of academic and vocational learning in order to combine the learning of broader conceptual and analytical skills with specific occupational and technical skills.

## Broadening Industry Understanding

Another trend within vocational education revolves around interpretations of the Carl Perkins legislation. The language of the Perkins Act not only calls for the integration of academic and vocational education but also states that students should receive education in broad aspects of industry. The Act describes these aspects as: business planning, management, finance, underlying principles of technology, technical and production skills, labor, community, and health, safety, and environmental issues as they pertain to an industry.

This directive expands considerably the scope of vocational technical education and is intended, according to the House reports on the Perkins reauthorization, to bring a comprehensive orientation to vocational education rather than a highly specific job or skills-based training approach. Coupled with the integration of academic and vocational education, the breadth of instruction in all aspects of an industrial world is designed to encourage "more advanced skills in thinking, problem-solving and comprehension." (U.S. House of Representatives, 1989)

## Industry Partnerships

Massachusetts has a long history of building partnerships between industry and educational institutions, including vocational education programs. A level of partnership is built into the very structure of our vocational education system through the use of program advisory committees. Beyond these committees, however, the range of participation by industry in vocational education is extremely varied. Some companies become actively involved in refining curriculum and even participate in the instruction. In other cases, companies provide supervised internships and help to build capacity by sharing state-of-the-art technologies.

There are a variety of reasons for developing closer relationships between real work environments and the classroom, including:

- Vocational schools need the link to industry in order to make learning more relevant to changing workplace needs.
- Integrated theoretical and applied learning can be enhanced by exposure to workers and the workplace through experiences, such as summer internships, cooperative study programs, and field trips.
- Partnership programs can help vocational schools replace and add to their equipment in order to keep pace with the equipment used in industry.
- Partnerships can help vocational schools develop and revitalize programs such as industrial technology.
- Through partnerships, vocational schools and students can build relationships with companies that enhance employment opportunities after graduation.
- Partnerships offer companies the opportunity for appropriately designed, cost effective, nearby training programs for their existing employees that will enhance their competitiveness.
- Companies have the opportunity to have an impact on the education of potential employees in order to ensure a well-prepared future workforce.

Many vocational schools are currently involved in partnerships with companies, and this type of mutually beneficial arrangement may become increasingly attractive as schools and firms seek to maximize their competitiveness in a rapidly changing environment.

**Customized training and the integration of adult and high school students:** The partnership developed by P&G and SSVT and others across Massachusetts demonstrate that secondary vocational schools can provide customized training for business and industry. To a more limited extent, these programs have shown that adults can participate successfully in classes that also serve traditional high school age students. The appropriateness of both areas, however, are still the subject of some debate in Massachusetts and other states. In order to develop a broader perspective on the experiences of secondary vocational schools in serving adults and in the delivery of customized training, we interviewed vocational educators in New England and several other states.

The following are summaries of their comments:

1. **Customized training programs are usually provided by post-secondary institutions or in evening programs for adults at area vocational**

**centers.** Generally speaking, secondary vocational schools are not yet heavily involved in providing customized training programs. There are examples in Massachusetts, some of which are discussed in a following section (page 53). In Rhode Island, customized training programs are offered in the evening at secondary school sites; however, these classes are not necessarily taught by the faculty members who teach in the day programs at the secondary school. In New Hampshire, secondary schools are involved in customized training on a limited basis, and vocational centers now under construction will have "flexible space" that can be used for customized training programs. In Vermont, the area technical centers that have traditionally served younger students are now responding to the particular needs of such companies as Digital Equipment Corporation, Lane Press, Simmonds Precision, General Electric, Bread Loaf Construction, Wyeth Nutritionals, First Vermont Bank, as well as others.

2. **Generally, it is difficult to include adults in the regular day program offered by secondary vocational schools.** The difficulty is attributed primarily to three factors: (1) scheduling classes that accommodate adults/company employees as well as faculty and regular class schedules is often a complicated process; (2) local policymakers are influenced by citizens' apprehensions concerning perceived liabilities of including adult women and men in classes with adolescent girls and boys; and (3) faculty members are not accustomed to working with adults. In those schools that have overcome traditional biases and admitted adults, however, the results have been quite positive. For example, a few vocational schools in Massachusetts are integrating their classes with success. In Michigan, two-thirds of the enrollment in a secondary vocational center is now comprised of adults, whereas that center had traditionally served adolescents during the day. In Rhode Island, to a limited degree, adults are enrolled in day classes with traditional students. In Vermont, 750 of the 5,000 adults enrolled in Adult Technical Education Programs are participating in daytime secondary programs with younger students at no charge to the adult student. According to technical educational officials, these instructors report that the "Space Available Adult" program has had a "tremendously positive impact on the classroom atmosphere." (*Newsletter*, Adult Technical Education Association of Vermont, February 1992) Vocational education officials in New Hampshire also report that in the secondary schools where adults are enrolled in day programs, the adults have been "good role models" for the younger students.
3. **In order to develop and serve new markets, secondary vocational administrators must acquire the support of policymakers, faculty, industry representatives, and citizens.** Because these programs are often new to schools, they require certain adjustments. The participation of adults in daytime classes is not part of the culture of typical secondary vocational schools; therefore, school officials, together with the citizens and representatives of business and industry, must develop strategies to demonstrate the benefits of developing these programs, including sharing the success of secondary schools that have customized training programs and serve adults. These same people need to help develop and implement strategies for marketing and providing customized training programs in vocational schools.

## Development of Performance Standards and Measures

Federally funded vocational education programs are required to develop performance standards and measures for: (1) learning, *i.e.*, the acquisition of academic and vocational skills; (2) performance in the labor market after leaving vocational education; and (3) accessibility, *i.e.*, access to courses and programs, completion of programs, and entry into the labor market for students with special needs. The federal requirement for the development of performance standards and measures brings a greater sense of urgency to the matter of addressing some of the vocational education issues above at both the state and local levels.

Following the descriptions of many of the major trends in vocational education, both in Massachusetts and the nation, the next section provides a sample of industrial partnership programs and articulation collaborations in Massachusetts.

## A Sample of Other Massachusetts Industrial Technology Partnership Programs

We interviewed representatives of a number of schools—suggested by our own staff, the Department of Education, or others—in order to explore other industrial technology partnership programs developed at vocational technical schools and community colleges in Massachusetts. Several schools in Massachusetts are participating in industrial technology partnerships, and we focused on these programs; however, we also spoke with schools involved in other types of partnerships. The specific design of each program and the role of the partners varies from case to case, but there are some common denominators: the programs are usually designed collaboratively and the industrial partner often provides equipment, internships, or cooperative jobs, links to other businesses, and jobs upon graduation. All of the interviewees were enthusiastic about their industry partnerships. They identified many benefits and few problems.

We also surveyed representatives of schools involved in innovative articulation collaborations. These programs do not focus on manufacturing technology, but they are interesting models of preparation for work.

**Vocational technical school programs:**

The vocational technical schools that we surveyed have developed a variety of partnership programs with manufacturers. Our focus was on programs that are designed to train existing company employees, but we will also note some interesting programs that serve the high school population.

*Assabet Valley Regional Vocational High School* has day and evening programs that are open enrollment, competency based, and individualized and that integrate high school students and adults in the same classes. Assabet has developed a variety of partnership programs with manufacturers. Coughlin Electric Company in Worcester is establishing a fiber optics division. Assabet teachers are helping Coughlin to set up their fiber optics laboratory, and Assabet will be able to use this lab to teach their students. Assabet is also training Coughlin's staff in Assabet's electronics lab, so that Coughlin does not have to develop an electronics lab of their own. Assabet also developed a training program for Digital model makers. These workers had sheet metal skills, and Assabet trained them in machining skills during an eight-week program. Stratus Computer, Inc., has given Assabet computing equipment and software to train students who, in many cases, will then be hired by Stratus. Assabet also has an automotive technician program in partnership with

Chrysler Motors Corporation.

*Greater New Bedford Vocational Technical School* has conducted a few machine shop training programs for companies in their area. General training and more specialized, computerized machining training have been provided for the workers of local companies. The school is flexible in its scheduling of programs; they have both day and night school classes. Greater New Bedford advertises its training programs through the Chamber of Commerce and finds this an effective linkage to local companies.

*Keefe Technical School* has an informal relationship with BOSE Corporation. BOSE has donated equipment to the school as well as hired Keefe students. An instructor from Keefe is paid by BOSE to train BOSE employees on safety. Keefe along with several other schools, has an automotive technician partnership program with a large automobile manufacturer. Keefe's is with Toyota USA. Each student receives a two-year associate degree—Massachusetts Bay Community College provides the academic portion of the program, and Keefe provides the hands on skill training. Toyota hires virtually all of the graduates and also provides training for the instructors, student internships, student scholarships after the first year, and tools for the students. Toyota began this program with Keefe Tech and proceeded to replicate it in 55-60 locations across the country.

*Minuteman Vocational Technical High School* has done CAD training for several companies such as Mitre Corporation and Raytheon Company. They have developed other kinds of partnerships, which include outplacement training for General Motors Corporation and an associate degree program in automotive training for the high school population, also with General Motors. In addition, Minuteman has developed an interesting partnership with MIT Lincoln Laboratory, Digital Equipment Corporation, and Raytheon. The goal of this partnership is to develop further technical literacy among high school and adult graduates of the program. The companies have been involved in the planning and curriculum development that will be continually reviewed and updated as necessary. As part of this program, they received a grant from the National Science Foundation to develop a "live" production line that would give students the opportunity to learn about all aspects of production, including quality control. Over time, Minuteman students will actually manufacture a Digital product; they expect to be in production by the end of the year. Because this group also felt that high school was too late to begin technical literacy education, Minuteman provides an instructor who teaches junior high school students from three area school districts in a science laboratory in Lancaster, Massachusetts.

*Quincy's Center for Technical Education* concluded a program one year ago with Pneumatic Scale Corporation. They held two machine shop training courses and one electronics training course at the school in the late afternoon during combined release and employee time. Pneumatic Scale described their training needs, and the Center developed the curriculum. The Center accepted equipment in lieu of payment for the training and is now hoping to develop a more advanced course in electronics to be offered to Pneumatic's employees.

*Shawsheen Valley Vocational Technical School* has developed several types of partnership programs. In terms of manufacturing technology programs, Shawsheen began working with three companies to develop three courses—Microwave Bonding, Electronic Test Technician, and Quality Control Technician. The companies helped design the curricula, which continues to be modified, provided equipment and facilities for training, and provided internships. The programs are offered both during the day and at night. The adult students use the same facilities as the high school students, but they are segregated. The Microwave Bonding course is no longer offered due to the recession and lack of need. The other two programs are in their fifth year, and now eight companies have participated in this partnership.

*Tri-County Vocational Technical School* developed an interesting partnership with Texas Instruments (TI) to train students for employment at TI. The curriculum was developed by Tri-County teachers and TI engineers and was implemented three years ago. Juniors in the industrial technology/welding program, who are both qualified and interested, are given the additional curriculum. The goal of the training is for these students to be able to operate highly sophisticated optical hydraulic welding equipment, using mechanical, electronic, and computer skills. Students spend the summer of their junior year at TI and in a co-op program in their senior year, during which they spend half their time on-site at TI. To date, all of the students who have participated in the program are working successfully at TI.

### Community college programs:

Certain community colleges are also developing industry training partnerships.

*Massasoit Community College* has had several partnership programs with Massachusetts businesses, including manufacturers; these partnerships have not involved industrial technology training. Massasoit has provided manufacturers' employees with basic programs such as GED and ESL, as well as outplacement training in such areas as heating ventilating and air conditioning, electronics, and diesel mechanics.

*Springfield Technical Community College's (STCC)* Dean of Continuing Education directs both the Center for Business and Industry Development (CBID) and the Western Massachusetts Center for Advanced Technology (WMCAT). Under his auspices and through these Centers, STCC has developed numerous business and industrial training partnerships. Many of these programs focus on business and computer skills training. For example, STCC is a designated training site for several different computer and software companies. Through these contracts, STCC trains the employees of local companies. Under WMCAT, STCC has developed training partnership programs with several nearby companies in areas such as electronics, computerized numerical controls, programmable logic controls, CAD, CAM, and robotics. The training programs are flexible regarding class schedules (evening, day, weekday, or weekend classes), sites (at the school or the company), and payment (companies pay for the training with regular payments, donated equipment, other in-kind contributions, or any combination of the above). STCC professors or company personnel, who have been trained by STCC, teach the courses. STCC always collaborates with each company on the curriculum, the instructor, the academic credit arrangements, and so forth to ensure that the company and the workers get exactly what they need. Milton Bradley Company and Titeflex Corporation are two of their industrial technology partners.

### Tech prep and collaborative programs:

Many schools are exploring or are currently involved in innovative articulation and collaborative programs designed to ensure that their students are better prepared for their chosen fields, are encouraged to continue their education, and are faced with as few obstacles as possible in the education process. SSVT is involved in a tech prep consortium, and a few other examples of Massachusetts schools pursuing such programs follow.

*The Merrimack Valley Occupational and Tech Prep Educators Collaborative,* which began roughly one year ago, consists of Greater Lowell and Whittier Regional Vocational Technical Schools, Greater Lawrence and Shawsheen Valley Technical High Schools, and Middlesex and Northern Essex Community Colleges. The first phase of the collaboration focused on articulation issues. The schools developed different options and programs including 2+2, 4+1, 4+2, and 4+1+1 programs, and offered many of them to adults as well as high school students. Their first major collaborative effort is a joint biotechnology program, in which they have agreed on the core courses as well as the technology in which each school will specialize.

*North Shore Regional Vocational Technical High School* is in the process of developing a manufacturing technology program in conjunction with North Shore Community College. It will be a 4+2 tech prep program. The two schools are working closely with industry partners to develop and validate the curriculum. Their goal is to create a program that is on the cutting edge of training students to be flexible and prepared to work in an environment where cross training and the larger view of the manufacturing process are crucial to success.

*Springfield Technical Community College (STCC)* developed thirty-eight separate 2+2 agreements with area high schools in fourteen different program areas. In addition, STCC is a member of the Tech Prep West project, a three-year, grant-funded collaborative agreement among three area community colleges and eight area technical/vocational high schools intended to strengthen high school academic skills as well as encourage continuation on to a post-secondary education.

As mentioned earlier, many other tech prep programs exist around the State, either in place or in the development stage. This trend is one that seems to have taken hold among vocational schools and community colleges throughout Massachusetts.

**Partnerships—benefits, problems, and the future:**

From the schools' perspectives, the benefits associated with school/industry partnerships are several and far out-weigh the issues. Developing a relationship, close in some cases, with a company or companies has several potential advantages. Our interviews uncovered the following:

- Aids the school in its efforts to stay current on new technology, both equipment and know-how.
- Provides valuable input to curriculum design; ensures that curriculum is integrated, current, and industry-responsive.
- Provides equipment for training.
- Helps to motivate teachers through real world contact.
- Provides exposure for students to the world of work.
- Provides employment opportunity for students both during school and after graduation.
- Gives students the opportunity to learn from adults in the classroom.
- Expands a school's base of activity beyond the high school level.
- Helps the community by providing opportunities for high school students and strengthening the workforce for businesses in the area.

As schools describe the advantages of creating partnerships, it is clear that, taken as a group, these partnerships have a major positive and revitalizing impact upon schools. Companies also benefit, the type of benefit depending on the form of partnership. For example, customized training programs provide companies with appropriately designed, flexibly structured training for their current workforce. Other types of partnerships help to ensure that the future workforce available to these companies, in the near- or long-term, is better prepared for work.

Developing partnerships of this kind inevitably creates certain issues. The issues mentioned were not, however, major stumbling blocks but rather smaller obstacles to be worked through in the development process. Union issues that affect both teachers and company employees, integrating adults into a student environment, time required of teachers and administrators to develop and manage the partnerships, and the set-up and maintenance costs for donated equipment were some of the issues mentioned by schools. Because these issues exist as potential stumbling blocks, it is important to acknowledge them early and to create joint strategies for overcoming them before they jeopardize the success of the partnership. For example, administrator and/or faculty planning and development time must be built into the process upfront through a rearrangement of responsibilities or release time, as appropriate.

All of the schools surveyed said they would like to develop more partnerships, both for training current company employees and preparing potential employees—their students. Some schools are actively pursuing new partnerships through their advisory boards and their Chambers of Commerce and by approaching CEOs directly, while others are developing strategies for locating new partners. A few schools mentioned that developing these partnerships is not an easy task in the best of economies and that they are finding it particularly difficult in the current recession. Given the presently difficult economic time, it might be advisable for schools to approach companies with partnership suggestions that significantly benefit companies in the short term, *e.g.*, customized training programs, and move into other types of partnership programs at a later time.

However these training and education partnerships are realized, it is clear that they are important to our schools, our companies, and our State's economic health. As one school official commented: **"Our workforce needs to be extremely productive and versatile with strong creative and critical thinking, problem-solving, and communications skills. Continued and expanded partnerships between schools and manufacturers that result in the highest quality training of our current and future workforce are critical to our competitiveness and, therefore, our future."**

# CONCLUSIONS AND RECOMMENDATIONS

BSSC's involvement with industry and with educational institutions over the last several years helped shape this report and the types of questions that framed the research. BSSC has focused its efforts on building educational and industry partnerships to serve the economic and workforce development needs of the Commonwealth and to help build the capacity of educational institutions to offer courses and curricula.

This experience base has helped us evaluate the Industrial Technology Program at SSVT. Our interest in assisting both industry and the educational community helped us relate P&G's training needs to SSVT's need for an academically viable program.

It is our firm belief, which is substantiated by the data that we collected and analyzed, that this type of partnership is especially appropriate between vocational education and manufacturing. We offer our conclusions and recommendations as suggestions for strengthening such partnerships.

- Vocational education administrators (state and school-based) should keep abreast of manufacturing trends and determine how to best support and take advantage of these trends.
- Vocational education administrators (state and school-based) and businesses are natural partners in the design, development, and implementation of appropriate initiatives, such as the integration of academic and applied learning, apprenticeships, and customized training programs.
- Properly planned, school/industry partnerships hold many benefits and relatively few drawbacks for vocational/technical schools and should be pursued in forms that meet the particular school's needs and in ways that can help revitalize their industrial technology programs.
- Companies should be prepared to develop partnerships with vocational technical schools in order to have a positive impact on the nature of industrial technology programs that will train the workforce of the future.
- Even though demand for manufacturing labor in Massachusetts is not growing in absolute numbers, there is a market, which is recognized by both manufacturing firms and labor representatives, for vocational technical education to train our existing and future workforce. Customized training programs are one form of partnership that can meet the needs of this market.
- In order for vocational students (high school and adult) to be successful in a rapidly changing workplace environment, they need to receive an integrated academic and applied education that emphasizes communications, critical thinking, and problem-solving skills in industrial technology education. This education can range from course curricula that combines theoretical and applied learning, such as Principles of Technology, to articulation agreements, such as tech prep programs, to ensure that students receive both the academic and vocational training.

## Specific Program Conclusions

Our review of the industrial technology program at SSVT began with a relatively detailed description of program development. In our view, the amount of preplanning and development devoted to the program is one of its strengths as well as a major contributing factor to its success. Each partner invested considerable time and thought in the program design. Expectations were clearly developed, and outcomes, which represented the interests of P&G, SSVT, and the participants in the training teams, were clearly defined. P&G's project management team involved a significant number of employees in the design of the program. This close attention to the training lasted throughout the year and—along with the efforts of the principal instructor—is, in part, responsible for the program's success.

From the customer's perspective, the program was successful. When we interviewed both groups—the P&G employees and their supervisors, who saw the results of the training—we found the nearly uniform view that the instructional delivery and the skills gained met expectations; the large majority of the students reported having gained valuable and useful skills. As a result of their acquiring these skills, they realized broader outcomes. Supervisors reported that students were able to perform new maintenance and troubleshooting tasks, that their understanding of the equipment and their ability to communicate with more technically trained employees have increased, and that they now work with greater confidence.

From SSVT's point of view, the program met, and sometimes exceeded, their expectations with regard to P&G's willingness to be involved in the planning and design of the program, to commit resources for instruction, equipment, and supply costs, and to work with some of the "givens" of a vocational technical high school environment. Further, the program helped to revitalize SSVT's manufacturing program.

When we surveyed other industrial employers and labor officials, we found that the basic curriculum seemed to be easily transferable. Although they had suggestions for improvement and expansion, company representatives found almost all of the program's skill areas relevant to the production processes in their own companies. Several firms suggested adding information on problem-solving and quality concepts to the basic curriculum. In addition, we identified more advanced competencies, such as intermediate troubleshooting, computer-driven manufacturing technologies (CIM, CAD), and an understanding of PLC's and other electronic systems, that could form the basis of an intermediate to advanced industrial technology course of study.

Most companies reported a need for this type of program and had favorable impressions of the quality of instruction at vocational schools generally and of programs at SSVT specifically. It is our conclusion that there is indeed a market for this program and that SSVT should refine and modify the current curriculum as well as develop an advanced curriculum to accommodate a wider variety of companies and industries.

This program is an example of an effective industrial partnership and customized training program and as such fits squarely within the trends of vocational education. Although not groundbreaking, its structure is somewhat unique in that training runs during the school day and parallel to the high school students' program. Although full integration of adult students with high school students was not achieved in this program, other schools are moving in this direction. Given the benefits associated with integration, we recommend it.

Not only do we feel that this program has the potential to be institutionalized at

SSVT, but we also conclude that it could be replicated in other schools to serve a variety of industries. It can be the high quality service, offering "value-added" training, that will help Massachusetts manufacturers and the industrial workforce achieve higher levels of productivity and job quality.

## Recommendations

Our recommendations are directed toward three audiences: SSVT, Massachusetts vocational technical schools, in general, and Massachusetts manufacturers. The recommendations for SSVT are specific to this program and focus on refining this curriculum, taking the next steps, and attracting new customers. Our recommendations for Massachusetts vocational technical schools and industry partners include suggestions for vocational education *vis a vis* industry needs as well as suggestions for the successful development of partnerships and customized training programs.

**Recommendations for SSVT:**

- To expand their customized training effort, SSVT's administration must actively market this program to the industrial community and then be prepared to communicate at length with and respond to employers and their interests in specific elements or refinements of the curriculum and program design.
- Introductions to electrical circuits and electronics (PLCs) should be added to the basic curriculum; these and other more advanced manufacturing technologies should form an advanced curriculum.
- If the program is to be offered to other companies, a greater emphasis on problem-solving techniques and an introduction to, for instance, continuous improvement, team skills, and standard concepts of quality tools and procedures should be integrated into the basic curriculum, which will require staff development and an administrative commitment to curriculum development in these additional areas.
- SSVT's administration should investigate ways of offering specific and detailed course material in problem-solving and team development as well as hazardous waste handling and safety issues, which they may find are too specialized for the basic curriculum.
- Although not a large issue at P&G, many of the firms that we surveyed report language skill needs in their multi-language plants. The school should seek ways of offering or coordinating with an ESL or language skill program.
- Although the program adequately addresses the specific learning requirements and performance objectives of P&G's employees, it is important to find and use a satisfactory method of gauging the validity of the performance objectives for other industries and assessing that skill competence has been demonstrated.
- SSVT should develop ways to more fully integrate adult trainees with the traditional high school students.
- SSVT administrators should formally assess the P&G industrial technology curriculum and take the necessary steps to integrate this material into their regular curriculum as appropriate.
- SSVT should further develop their career awareness program to attract mid-dle school students to SSVT and to the revitalized industrial technology program.
- SSVT should develop articulation agreements and collaboratives based on the revitalized industrial technology program.

**Recommendations for vocational technical schools and industry partners:**

- Manufacturers can turn to vocational technical schools to help give voice to their need for an educated, involved workforce.
- The manufacturing industry represents a substantial market for customized training and other partnership programs that vocational schools should aggressively pursue. Given the potential benefits that can accrue to the schools and to industry, schools should develop a marketing plan that targets area manufacturing firms and initially focuses on the schools' current capacity and existing relationships. Likewise, manufacturing firms should seek out vocational technical schools to train their workforce.
- Necessary to the success of such a program as this is an upfront investment of time for planning and exploring the needs and expectations of all partners, a commitment to providing the necessary resources, and a commitment to on-going evaluation and revision. Schools and companies should set clear goals for their training programs.
- Manufacturing companies should make a long-term commitment to a training curriculum *vs.* a single course to provide the skills necessary for the company to realize its business goals.
- Companies should be prepared and willing to invest money and additional resources in training programs.
- In developing a basic approach to providing training for manufacturing firms, vocational technical schools should be flexible in considering the needs, interests, and constraints of the industry partner:
  - Class schedules must be flexible and meet the requirements of the partner firm(s), *e.g.*, days, nights, weekdays, weekends, and flexible hours.
  - The training site should also be flexible, *e.g.*, at the school, on-site at the company, or both.
  - The differing needs of adult students should be taken into consideration as appropriate, *e.g.*, elements of the Special Program Features of the SSVT/P&G Program.
- In general, training programs should combine job-related theory and hands-on learning and include such broadly applicable skills as troubleshooting, critical thinking, problem-solving, communication, and teamwork skills.
- Vocational schools should plan to integrate adult and high school students in classes but should anticipate possible resistance to this effort, and plan accordingly.
- Vocational technical schools should transmit a more positive and realistic image of the manufacturing field to students and implement aggressive industrial technology career awareness programs to include orientation sessions, career/job fairs, and sample classes and labs, evaluating and revising them as necessary. Manufacturing firms should participate in these career/job fairs.

In conclusion, by all accounts, the first year of the SSVT and P&G Industrial Technology Program was a success. But this is just the first step: They are now in the process of planning the next year. While some program elements are unique, the program both exemplifies several trends in vocational education and highlights the synergism between the direction and the needs of vocational education and those of manufacturing. Such partnerships make sense and should be pursued by both parties. We have offered this analysis and our recommendations as a basis for and a guide to creating manufacturing partnerships.

# APPENDIX A
# LIST OF INTERVIEWEES

**South Shore Vocational Technical High School**

Paul Bourgea, Instructor
John Kosko, Principal, Abington Campus

**Procter & Gamble**

Don Rowell, Plant Training Coordinator
Three department managers
Seven students of the program (five were machine operators and two were mechanics)

**Manufacturers**

| | |
|---|---|
| Barcolene Company | Mike Sabina, Plant Manager |
| Boston Popcorn | John Kowalchik, Director of Manufacturing |
| Brady Enterprises, Inc. | Ed Sullivan, V.P., Manager Manufacturing Operations |
| | Rick Lenihan, Plant Manager |
| Concord Foods, Inc. | Don Dillion, V.P., Manufacturing |
| Econocorp, Inc. | Jack Bowers, Manufacturing Manager |
| Friskies Pet Care | Brian Robinson, Plant Manager |
| KAO Infosystems | Steve Joslin, Manufacturing Manager |
| Mercury Metals, Inc. | Tony Giorgio, Plant Manager |
| New Can Company, Inc. | Jim Razulis, Manufacturing Manager |
| Norwood Stamping Company | Jordan Stone, Vice President |
| Ocean Spray | Barbara Denker, Human Resources Manager |
| Powers Pharmaceutical | Ron Breau, Operations Manager |
| Universal Products, Inc. | Steve Rubin, Vice President |
| Washburn Candy Corporation | Jim Gilson, Product Manager |

**Vocational Technical Schools and Community Colleges**

| | |
|---|---|
| Assabet Valley Regional Vocational High School | David Tobin, Superintendent |
| Assabet Valley Regional Vocational High School | Stephen Pronovost, Principal |
| Center for Technical Education (formerly Quincy Vocational Tech) | Joseph Mazzarella, Principal |
| Greater Lowell Regional Vocational Technical | Nelson Burns, Director of Adult Post-secondary Program |
| Greater New Bedford Vocational Technical | Jeff Riley, Superintendent |
| Joseph P. Keefe Technical School | Paul Bento, Superintendent and Director |
| Massasoit Community College | Al Asiaf, Director of Business and Industry |
| Merrimack Valley Occupational and Tech Prep Educators Collaborative | Helen Gorenson, Executive Director |
| Minuteman Vocational Technical | Dr. Ron Fitzgerald, Superintendent |

| | |
|---|---|
| North Shore Regional Vocational Technical | Patricia Carlson, Superintendent |
| Shawsheen Valley Vocational Technical | John McDermott, Associate Superintendent |
| Springfield Technical Community College | Dr. Thomas Holland, Dean of Continuing Education<br>Director, Center for Business & Industry Development.<br>Director, W. Mass. Center for Advanced Technology |
| Tri-County Vocational Technical | Jack Jones, Superintendent |

**Labor Officials**

Joe Broda, President, Local 1451 of IAM, Townsend-Textron Manufacturing
Charles Colby, President, Local 444, RWDSU, Pneumatic Scale Company
Charles Ferria, Business Agent, New England Joint Board, RWDSU at New Can Company, Inc. and Ivex Coated Products Corp.
Bob Leighton, President, Local 269 IUE, Armstrong World Industries
Richard Wilson, Steward, Local 1505, IBEW, Raytheon Corporaton

**Additional Persons Contacted**

| | |
|---|---|
| Pam Barry | Massachusetts Department of Education |
| Joe Casello | Office of Vocational and Adult Education, U.S. Department of Education |
| Chip Evans | Vermont Department of Education |
| Terry Fancher | South Shore Chamber of Commerce |
| Brian Gilmore | Associated Industries of Massachusetts |
| Jim Green | Massachusetts State Council on Vocational Education |
| Richard Kramer | Division of Vocational and Adult Education, Rhode Island Department of Education |
| Ruth Maxey | Specialized Programs for Industry, Oklahoma Department of Vocational Technical Education |
| John McDonagh | Massachusetts Department of Education |
| Dr. G. William Porter | Director of Vocational-Technical Services, New Hampshire Department of Education |
| Larry Rosenstock | Cambridge Rindge and Latin School |
| Dr. Bill Rude | Michigan Vo-Tech Education Service |
| Dr. Peter Seldman | The National Center for Research in Vocational Education, University of California at Berkeley |
| Herb Shipman | Addison County Area Vocational Center, Middlebury, Vermont |
| Richard Sunderland | National Tooling and Machine Association |
| Judith Wagner | Center on Education and Training for Employment, Ohio State University |

Note: All of the interviews/discussions were conducted in person, except those listed under the Vocational Technical/Community College and the Additional Persons Contacted sections.

# APPENDIX B
# INTERVIEW INSTRUMENTS

## MANUFACTURER FOCUS GROUP INTERVIEW INSTRUMENT

**General descriptive questions about the workforce and the skills they need:**
We are interested in your perceptions of how you view the current skills of machine operators and the direction that you see the skill needs moving. Are the skill needs increasing or decreasing?

1. Given your productivity goals, how would you describe the skill levels of your machine operators? About right? Too low or not the right skills?
2. Who is responsible for machine maintenance in your shop?
3. Do your machine operators do any maintenance work on machines?
4. What are the problems you run into most often with your machines? That is, when your machines break down, what is usually the problem?
5. When a piece of equipment needs repair, what is the process to diagnose the problem and then get it fixed?
6. Would it be helpful to you if operators could troubleshoot their equipment?
7. Would you want machine operators to repair equipment?
8. If yes, to what extent do you want operators fixing machines?
    Cleaning?
    Lubricating?
    Troubleshooting?
    Removing parts?
    Replacing parts?
    What else?

**Questions about the South Shore Vocational Technical High School Industrial Technology Program:**
Now we would like to get your responses to the curriculum that was developed at South Shore Vocational Technical in a training program created for the Procter & Gamble Manufacturing Company. We are interested in your views on the objectives of the program in relation to what you see on your own shop floor.

9. Take a look at the following set of skills and knowledge that was developed in the Industrial Technology Program. Are these the kinds of skills that you think are unnecessary for a machine operator, necessary, valuable?

| Competency | Unnecessary | Necessary | Valuable |
|---|---|---|---|
| A. MATH AND MEASUREMENT | | | |
| B. CARE AND USE OF HAND TOOLS | | | |
| C. MECHANICAL FASTENERS | | | |
| D. LUBRICATION | | | |
| E. BELTS AND PULLEYS | | | |
| F. CHAINS AND SPROCKETS | | | |
| G. BEARINGS | | | |
| H. GEARS AND GEAR REDUCERS | | | |
| I. COUPLINGS | | | |
| J. PUMPS | | | |

10. What changes would you make to this set of skills? Additions? Would you take anything out?
11. Do these skill areas get to the issues listed in Question #8?
12. What other, more advanced skills would be important to follow after these topics? For example: electrical systems, electronics, hydraulics.
13. What else would it be helpful to have training in? For example:
    A. Working in teams
    B. Problem-solving
    C. Analytical skills
    D. Quality processes
14. The Procter & Gamble Manufacturing Company donated equipment to get the program started. If you were considering a program like this, would you want your employees to use equipment specific to your company or could they benefit from training on broadly similar kinds of equipment and machinery?
15. Have you or your employees taken training at vocational schools in the past?

    What are the pluses and minuses?
16. Has your company hired any vocational school graduates, and if so, how do they compare to other new hires?

**Questions relating to training activities now used by the companies:**

Now we would like to discuss your current policies and practices regarding training. We are particularly interested in what you do now to encourage training for the work-force.

17. Do your companies now provide any kinds of skill training for employees? If yes, what types?

18. How is this training provided, for example?
    - A. Training supplied by equipment vendors
    - B. On-site technical training by consultants
    - C. Company sponsored off-site technical or skills training
    - D. Tuition reimbursements for job-related training
    - E. Joint labor/management endorsed or sponsored training
    - F. Training provided by company personnel
19. Do you also encourage employees to seek professional development on their own? How do you encourage this?
20. Does your current training adequately meet the company's needs?
21. What factors would be most important in designing a skills training program for your employees? For example:
    - A. Training should be very job-specific.
    - B. Training should cover a broad set of work-related basic skills.
    - C. Training should focus on one skill area or topic that employees need most.
    - D. Training should progress from basic to more advanced skills that employees will need in the future.
22. What are the most important logistical factors in whether or not you would recommend a training program or a provider? For example:
    - A. Cost of program
    - B. Location (travel time to training site)
    - C. Type of institution (for example, college, vocational technical school)
    - D. Time of day
23. The Procter & Gamble Manufacturing Company spent a considerable amount of time with school officials in planning this course of study; do you think this kind of time investment would pay off, and do you have time or people on staff to plan a training program?
24. Would you arrange paid release time for workers to take job-related training?
25. What are your guidelines regarding the cost of training programs?
26. Do you also have specific scheduling needs? For example, is it difficult to set up training programs for shift workers?
27. What are the hours of work into which company shifts fall *e.g.*, 7 A.M. to 3 P.M., etc.?
28. If your shop is unionized, does your bargaining agreement contain any specific language to promote training? What?
29. Are there any other areas of training needed by your employees that could be addressed by a vocational school? Did we miss anything you want to tell us?

We will be happy to send you a copy of the report that we produce about this program. South Shore Vocational Technical High School wants to offer their Industrial Technology Program to firms in its service area, and so if you might be interested in this kind of program, we will be happy to put them in touch with you.

**THANK YOU VERY MUCH.**

## PROCTER & GAMBLE MANAGEMENT INTERVIEW INSTRUMENT

1. What was the goal of the program?

2. Were your expectations met?

3. Was the program accessible to workers? Any logistical problems?

4. Does the curriculum meet the company's needs?
   Which areas should be expanded? Altered? Diminished?

5. In which other areas (within the company), could you see a program
   of this type working?

6. What is the benefit of working with a vocational school?
   What are the drawbacks?

7. Was South Shore Vocational Technical High School responsive to the needs of Procter & Gamble as the program unfolded?

8. Do you think the program was helpful to the workers on the job? What are the criteria? How is learning demonstrated, *e.g.*, productivity improvements?

9. What are the prerequisites that a worker should have in order to successfully participate in a program like this?

10. How does the program fit into the company's overall business plans? Does it coincide with the company's organizational structure/corporate culture?

11. What was the cost of the program to the company? Was the program cost effective? Worth the investment? Were there hidden costs?

12. Would you do it again? What would you change?

13. Where does Procter & Gamble go from here with this program?

14. What else should we know?

## PROCTER & GAMBLE TRAINEES INTERVIEW INSTRUMENT

1. What were your goals in taking this course?

2. Were your expectations met?

3. Was the curriculum appropriate to what you do on your job?
   What areas of the curriculum would you expand or reduce?

4. Was there too much, too little, or just enough work for you to do in order to complete the course?

5. How much time did you spend outside of class to prepare and/or complete assignments?

6. How do you know that you gained something from the program?
   Are you performing differently/more efficiently at work?

7. Was an orientation provided for you before you entered this program?
   Do you think that you were adequately prepared to enter the program
   or were there other things you would have like to have known beforehand?

8. How would you evaluate the quality of instruction?  Materials?  Equipment?

9. Were the logistics of the program workable, *e.g.*, was the school accessible, did the schedule work out well?

10. Is the vocational school an appropriate place to run a program like this one?
    Benefits?  Drawbacks?

11. Was the school responsive to your needs or concerns throughout the program?

12. Where do you go from here?  What are your next steps?

13. What else should we know?

# APPENDIX C
# REVIEW OF LITERATURE

EJ435379 CE523236
**Technology Education and the Cognitive Revolution.**
Johnson, Scott D.; Thomas, Ruth
Technology Teacher; v51 n4 p7-12 Jan 1992
ISSN: 0746-3537
Available from: UMI
Language: English
Document Type: JOURNAL ARTICLE (080); POSITION PAPER (120)
Journal Announcement: CIJAPR92

Five principles emerging from cognitive science research are as follows: (1) help students organize their knowledge with concept mapping; (2) build on what students already know; (3) facilitate information processing; (4) facilitate deep thinking; and (5) make thinking processes explicit. (SK)

Descriptors: Cognitive Processes; *Critical Thinking; Educational Principles; *Learning Theories; *Metacognition; Problem Solving; Research Utilization; Transfer of Training
Identifiers: Cognitive Research; *Concept Mapping; *Technology Education

EJ432152 CE522939
**Woodworking Technology.**
Kirk, Albert S.; And Others
School Shop Tech Directions; v51 n3 p13-19 Oct 1991
Available from Prakken Publications, P.O. Box 8623, Ann Arbor, MI 48107.
ISSN: 1050-3749
Language: English
Document Type: JOURNAL ARTICLE (080); TEACHING GUIDE (052); POSITION PAPER (120)
Journal Announcement: CIJFEB92

Three articles discuss the importance of wood processing to manufacturing and construction industries and the need for progressive change in the curriculum; the evolution of wood-based synthetic panel materials; and the technological advances in the computer control of machine tools and their incorporation into wood technology curricula. (JOW)

Descriptors: Construction Industry; *Curriculum Development Higher Education; Manufacturing Industry; *Numerical Control; *Problem Solving; *Technological Advancement; *Woodworking
Identifiers: Technology Education; *Wood Technology

EJ426621 CE522639
**The Green Revolution in Transportation. Resource Recovery. Technology Learning Activities.**
Technology Teacher; v50 n8 p7-8 May-Jun 1991
ISSN: 0746-3537
Available from: UMI
Language: English
Document Type: JOURNAL ARTICLE (080); TEACHING GUIDE (052)
Journal Announcement: CIJOCT91

These two learning activities provide context, objectives, list of materials, student activity, and evaluation criteria. The first involves an automotive class in developing a model alternative fueled vehicle, and the second involves the design of a useful recyclable product. (JOW)

Descriptors: *Alternative Energy Sources; *Auto Mechanics; Conservation (Environment); Design; Learning Activities; *Problem Solving; *Recycling; Secondary Education
Identifiers: Technology Education

EJ417772 CE522101
**A Conceptual Framework for Technology Education.**
Savage, Ernest; Sterry, Leonard
Technology Teacher; v50 n1 p6-11 Sep-Oct 1990
For part 2, see CE 522 102.
Report No.: ISSN-0746-3537
Available from: UMI
Language: English
Document Type: JOURNAL ARTICLE (080)
Journal Announcement: CIJAPR91

Features of this model for technology education are human needs and wants, problems/opportunities, resources, technological processes, technological knowledge, evaluation, and solutions/impacts. (SK)

Descriptors: *Models; Needs, *Problem Solving; Science and Society; *Technology
Identifiers: *Technology Education

EJ398907 EA523785
**Technology Education: Its Place in the Secondary School.**
Lauda, Daonald P.
NASSP Bulletin; v73 n519 p1-3 Oct 1989
Available from: UMI
Language: English
Document Type: JOURNAL ARTICLE (080); EVALUATIVE REPORT (142)
Journal Announcement: CIJAPR90

Technology education (based on an organized set of concepts, processes, and systems) is designed to replace traditional industrial arts programs (based on a study of materials, like wood or metals). At the secondary level, teachers can engage students in research and experimentation that cuts across the disciplines. (MLH)

Descriptors: Competition; Consumer Education; *Industrial Arts; *Interdisciplinary Approach; *Problem Solving; Secondary Education; Teaching Methods; *Technological Literacy
Identifiers: *Technology Education

ED334464 CE058566
**Technological Problem Solving: A Proposal.**
Waetjen, Walter B.
International Technology Education Association, Reston, VA.
1989
18p.
Available from: International Technology Education Association, 1914 Association Drive, Reston, VA 22091-1502

(cont. next page)

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($5.50 members; $6.50 nonmembers).
EDRS Price - MF01/PC01 Plus Postage.
Language: English
Document Type: POSITION PAPER (120)
Geographic Source: U.S.; Virginia
Journal Announcement: RIEDEC91
Target Audience: Practitioners

Examination of newer technology education materials reveals two recurring themes: one relates to curriculum content, familiarizing students with technology, and another to a technique of classroom instruction, i.e., problem solving. A problem-solving framework for technical education has the following components: (1) define the problem; (2) re-form the problem; (3) isolate the solution; (4) implement the plan; (5) restructure the plan; and (6) synthesize the solution. Language plays a significant role in the problem-solving process. Purposeful activity is a central component of problem solving. Teachers play an active part while students are solving problems. There are four kinds of questions teachers employ in helping students to solve problems: (1) memory and recall; (2) grouping or categorizing; (3) transformational; and (4) cognitive leap. Using this process, students solve a problem, develop cognitive and language skills, and become familiar with the technological process, instead of making a "project." By emphasizing an understanding of the process, learners can apply concepts. Teachers should be provided with technological problem-solving knowledge, skills, and activities. (32 references) (NLA)

Descriptors: Class Activities; Classification; Cognitive Processes; *Experiential Learning; Language Usage; Memory; *Problem Solving; *Recall (Psychology); Secondary Education; Teacher Role; *Technical Education; *Technological Advancement ; Thinking Skills

Identifiers: *Technology Education

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ED334407 CE058425

**An Overview of Mission 21. A Program Designed To Assist Teachers in Integrating Technology into Their Present Curriculum through a Problem-Solving Approach. Grades 1 through 6.**

Brusic, Sharon A.; And Others
Virginia Polytechnic Inst. and State Univ., Blacksburg.
Feb 1990
14p.
Sponsoring Agency: National Aeronautics and Space Administration, Washington, D.C.
EDRS Price - MF01/PC01 Plus Postage.
Language: English
Document Type: PROJECT DESCRIPTION (141)
Geographic Source: U.S.; Virginia
Journal Announcement: RIEDEC91

This booklet presents an overview of Mission 21, a project that promotes technological literacy in the elementary school classroom. Funded since 1985, Mission 21 has enabled graduate research associates and Virginia teachers to write and field test a technology education program for children in grades 1 through 6. Over 30 elementary teachers in 11 school systems have participated in field testing materials that integrate technology concepts into their present curriculum. Guide activities emphasize creativity using a problem-solving approach to learning. Activities for each grade level are as follows: (1) grades 1 and 2--transportation, explore, design, and space; (2) grades 3 and 4--machines, discovery, community, and connections; and (3) grades 5 and 6--communication, space colonization, invention, and energy/matter. Problem-solving models for grades 3-4 and 5-6 are included. The use of design briefs by students to examine a situation and act upon the problem is explained. Folios to document progress in the problem-solving process are described. Folios can be formatted in journal, chronology, or display formats. A list of regional program officers is included in the document. (NLA)

Descriptors: Creativity; *Curriculum Development; Elementary Education; *Elementary School Curriculum; Integrated Curriculum; *Problem Solving; *Technological Advancement; Technological Literacy

Identifiers: *Mission 21 VA; *Technology Education

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ED333003 TM012626

**Think about It, Too: Volume III, Part II. A Collection of Articles on Higher Order Thinking Skills. REACH: Realistic Educational Achievement Can Happen.**

Texas Education Agency, Austin.
Oct 1988
148p.; For a related document, see ED 298 141.
Report No.: GE9-302-01
Available from: Publications Distribution Office, Texas Education Agency, 1701 North Congress Ave., Austin, TX 78701 ($6.00).
EDRS Price - MF01/PC06 Plus Postage.
Language: English
Document Type: COLLECTION (020); RESEARCH REPORT (143)
Geographic Source: U.S.; Texas
Journal Announcement: RIEOCT91
Government: State
Target Audience: Teachers; Practitioners

This volume presents 22 papers that discuss thinking in the context of subjects taught in general education, special and vocational education, educational technology, and special programs. The key note article is: (1) "A Case for Higher Order Thinking" (G. Garcia Jr.). Under the heading "Educational Technology" are: (2) "Designing a Successful Problem Solving Inservice" (T. Boudrot); and (3) "Software to Encourage Problem Solving" (T. Boudrot). Under "General Education" are: (4) "Psychomotor Skills: The Discovered Element of Thinking" (D. Thrasher); (5) "Teaching Adolescents about Communicating in Families" (C. Klein); (6) "Thinking Skills and Driver Education: A Natural Partnership" (G. Peavy); and (7) "Thinking about Acting" (K. Wheetley). Under "Special Education" are: (8) "Learning To Learn: Executive Control Strategies for Handicapped Students" (A. Smisko); and

(cont. next page)

(9) "The Use of Graphic Organizers with Hearing-Impaired Students" (S. Cowan). Under "Special Programs" are: (10) "Developing the Thinking of Compensatory Students" (A. Pedroza); and (11) "Developing the Thinking of Students of Limited English Proficiency" (E. Gutierrez). Under "Vocational Education" are: (12) "Developing Critical Thinking Skills in the Health Occupations Laboratory" (J. Keeton); (13) "Improving Trade and Industrial Student Thinking Skills" (J. Cogdell); (14) "Send Us Your Thinkers" (B. Sullivan); (15) "Teaching Thinking in Industrial Technology Education" (N. Ballard); and (16) "Thinking through Vocational Home Economics Education" (J. Hetherly). Under "Thoughts across the State" are: (17) "Accelerating Learning Potential" (V. Post); (18) "A Shortcut to Understanding and Teaching Higher Level Thinking Skills" (M. Rice); (19) "Developing Thinking through Problem-Solving Programs" (E. Forte et al.); (20) "Principals: Taking the Lead in Thinking Skills" (C. Collins); (21) "Teaching Slower Learners Higher Level Thinking" (C. Marshall); and (22) "Vocational and Academic Education Join Hands To Nurture Student Thinking" (M. Hendrix). (SLD)

Descriptors: Cognitive Processes; *Educational Technology; Elementary Secondary Education; *General Education; *Special Education; Special Programs; *State Programs; *Thinking Skills ; *Vocational Education

Identifiers: Texas

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ED329711 CE057160

**Technology Education. Introduction to Technology. Grades 7 & 8.**

New York State Education Dept., Albany. Div. of Occupational Education Programs.

Sep 1987

313p.; For related documents, see CE 057 157-161.

EDRS Price - MF01/PC13 Plus Postage.

Language: English

Document Type: TEACHING GUIDE (052)

Geographic Source: U.S.; New York

Journal Announcement: RIEAUG91

Government: State

Target Audience: Teachers; Practitioners

This syllabus contains 10 modules that satisfy the one-unit requirement for technology education to be completed by the end of Grade 8 in New York. An introduction provides information on its use. Suggested content outlines of the modules follow. Module components include suggested teaching time; overview; enabling vocabulary; major concepts; performance objectives/supporting competencies; suggested instructional strategies; and suggestions for modifying instructional techniques or materials for handicapped students. Module titles are as follows: Getting to Know Technology; What Resources Are Needed for Technology; How People Use Technology to Solve Problems; Systems and Subsystems in Technology; How Technology Affects People and the Environment; Choosing Appropriate Resources for Technological Systems; How Resources Are Processed by Technological Systems; Controlling Technological Systems; Technology and Society: Now and in the Future; and Using Systems to Solve Problems. A glossary of terms is provided. Twenty-five model technology learning activities (TLAs) are included. Components are completion time; major concepts; overview; equipment and supplies; procedure; constants for infusion into the TLA; background references and resources; examples of evaluation; and appendixes with any necessary other materials. A final section of the manual, called technology learning briefs, contains 99 ideas for students. These present a problem, a brief, and constraints to produce an optimal solution. (YLB)

Descriptors: Behavioral Objectives; Classroom Techniques; Course Descriptions; Energy Education; Environmental Education ; Grade 7; Grade 8; Junior High Schools; Learning Modules; Natural Resources; *Problem Solving; *Science and Society; State Curriculum Guides; Teaching Methods; *Technological Literacy; *Technology

Identifiers: New York; *Technology Education

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ED323254 TM015494

**The Induction of Rules from Analog, Mental Models.**

Schwartz, Daniel L.; Black, John B.

Apr 1990

29p.; Paper presented at the Annual Meeting of the American Educational Research Association (Boston, MA, April 16-20, 1990).

EDRS Price - MF01/PC02 Plus Postage.

Language: English

Document Type: RESEARCH REPORT (143); CONFERENCE PAPER (150)

Geographic Source: U.S.; New York

Journal Announcement: RIEJAN91

This study investigated how people reason about simple mechanical devices and physical systems, and how reasoning methods and understanding of a device evolve over a period of exposure. Twelve students attending the Teachers College at Columbia University (New York) participated in the first of two experiments; and 10 students attending the same Teachers College participated in the second experiment and were randomly assigned to five dyads. The first experiment used a quantified protocol in which spontaneous hand movements were considered evidence of modeling; dramatic reductions in reaction time were evidence of rule induction. The second experiment organized subjects into problem-solving dyads. The inductive movement between analog models and number-based rules was documented for problems about gear movement. It was found that subjects rely initially upon an analog model until a satisfactory rule is induced. However, when a problem was introduced that led to failure of the rule, subjects returned to a model. Exophoric references were used as evidence that subjects were reasoning about models. Numeric expressions were taken as evidence of rule induction under the logic that the rule operates over numbers rather than gears. The strengths of each type of reasoning are discussed. Models are conceptualized as a quasi-empirical base from which to draw

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the basic patterns and relevant parameters for rule induction. Three figures are included. (TJH)

Descriptors: *Cognitive Processes; College Students; Higher Education; *Induction; *Mechanical Skills; Models; Motion; *Problem Solving; Reaction Time; *Thinking Skills

Identifiers: *Analogue Models; Dyads; Mental Models; Parametric Analysis; *Rule Learning (Mathematics)

EJ422361 CE522399
**Models that Link School and Work. From These Projects Could Come New Ways to Teach Job Skills.**
Vocational Education Journal; v66 n3 p29 Mar 1991
ISSN: 0884-8009
Available from: UMI
Language: English
Document Type: JOURNAL ARTICLE (080); PROJECT DESCRIPTION (141)
Journal Announcement: CIJJUL91
Six pilot worksite-based projects funded by the Department of Labor are described: preparing for metalworking careers in Pennsylvania; Workforce Los Angeles Youth Academy; Boston's Project Protech, preparation for health care careers; Maryland projects for manufacturing technology careers, high school tech prep, and at-risk youth; National Alliance of Business community-corporation linkages in Chicago and San Francisco; and electronics technician training. (SK)
Descriptors: Community Colleges; *Education Work Relationship; *Federal Aid; High Schools; *Job Skills; *Pilot Projects; Two Year Colleges; Vocational Education; *Work Experience Programs

EJ420871 CE522278
**The Perkins Act at a Glance.**
Wilcox, John
Vocational Education Journal; v66 n2 p16-17 Feb 1991
Report No.: ISSN-0884-8009
Available from: UMI
Language: English
Document Type: JOURNAL ARTICLE (080); POSITION PAPER (120)
Journal Announcement: CIJJUN91
Provides highlights of the Carl D. Perkins Vocational and Applied Technology Education Act of 1990. Includes information about basic state grants, tech prep, supplementary grants, consumer education, career guidance, community-based organizations, bilingual vocational education, and other programs. (JOW)
Descriptors: Bilingual Education; Career Guidance; Consumer Education; *Disadvantaged; *Federal Legislation; Postsecondary Education; School Business Relationship; Secondary Education; *State Federal Aid; *Vocational Education
Identifiers: *Carl D Perkins Voc and Appl Techn Educ Act 1990; *Technology Education

EJ401987 CE521155
**Technology Programs: A Technology Education Model for Ohio.**
Savage, Ernest
Technology Teacher; v49 n5 p8-12 Feb 1990
Available from: UMI
Language: English
Document Type: JOURNAL ARTICLE (080); POSITION PAPER (120)
Journal Announcement: CIJJUN90
Describes the Model Technology Systems Project, funded by the Ohio Department of Education to develop an articulated Industrial Technology Education Program K-12. The success of the pilot led to the expansion of the scope to include the delivery of technology education curriculum. (JOW)
Descriptors: *Articulation (Education); *Curriculum Development; Elementary Secondary Education; *Industrial Arts
Identifiers: *Ohio

EJ365137 JC504649
**A New Partnership for Today's Technology Programs.**
Kerekgyarto, George A.
Community Services Catalyst; v18 n1 p17-19 Win 1988
Available from: UMI
Language: English
Document Type: JOURNAL ARTICLE (080); PROJECT DESCRIPTION (141)
Journal Announcement: CIJMAY88
Examines the articulation of an industrial technology teacher education program between a university and a community college for the purpose of delivering a technology-based education program at the university. Outlines program needs that led to the articulation effort, factors associated with successful articulation, problems that developed, and logistical considerations. (DMM)
Descriptors: *Articulation (Education); Community Colleges; Higher Education; Industry; *Intercollegiate Cooperation; Program Descriptions; *Program Development; State Universities; *Teacher Education; *Technical Education; Technology; Two Year Colleges; *Vocational Education Teachers

ED336519 CE058858
**Missouri Industrial Technology/Technology Education Guide.**
Missouri State Dept. of Elementary and Secondary Education, Jefferson City. Div. of Vocational and Adult Education.
1991
578p.
Available from: Instructional Materials Laboratory, University of Missouri, 2316 Industrial Drive, Columbia, MO 65202 (order no. 60-0286-I: $35.80).
EDRS Price - MF03 Plus Postage. PC Not Available from EDRS.
Language: English
Document Type: TEACHING GUIDE (052)
Geographic Source: U.S.; Missouri
Journal Announcement: RIEFEB92
Target Audience: Teachers; Practitioners
This guide is Missouri's primary resource for planning, implementing, and evaluating Industrial Technology/Technology Education (ITE/TE). It contains 10 chapters: (1) a direction for ITE/TE; (2) planning the ITE/TE program; (3) planning ITE/TE facilities; (4) implementing a safety program; (5) creating ITE/TE's image (public relations); (6) teaching ITE/TE; (7) organizing and managing the ITE/TE program; (8) evaluating ITE/TE; (9) meeting professional responsibilities; and (10) helpful resources. A list of 138 figures and 3 tables

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is included. Chapter 10 contains an index of forms, an index of 72 Technology Activity Modules, and recommended ITE/TE competencies and articulation links depicted in graphic form. (NLA)

Descriptors: Articulation (Education); Competency Based Education; *Curriculum Development; Educational Facilities Planning; Employment Potential; High Schools; *Industry; Inservice Teacher Education; Job Skills; *Program Administration; Program Development; Program Evaluation; Public Relations; School Safety; Student Evaluation; Teaching Guides; *Technology

Identifiers: *Missouri; *Technology Education

ED335067 JC910313

**Partnership 2000: A Bridge to a More Effective California Workforce and a Continuing Challenge for Educational Excellence, October 1990-July 1991 . Project Number: 89-0132.**

Fujimoto, M. Jack; Carraway, Cassandra T.

Los Angeles Mission Coll., Sylmar, CA.

1991

25p.

Sponsoring Agency: California Community Colleges, Sacramento. Office of the Chancellor.

EDRS Price - MF01/PC01 Plus Postage.

Language: English

Document Type: EVALUATIVE REPORT (142); RESEARCH REPORT (143)

Geographic Source: U.S.; California

Journal Announcement: RIEDEC91

The goals and activities of Partnership 2000, a federally funded project administered by Los Angeles Mission College for the California community colleges, are described in this report. Introductory material indicates that Partnership 2000 was undertaken to link business, industry, government, labor, and the state's community colleges in cooperative economic development efforts pertaining to issues development, resource development, faculty growth, student internships, and articulation agreements. Following an outline of project objectives and anticipated outcomes, specific activities are reviewed, including: (1) an aviation articulation conference held at San Jose State University; (2) a health care issues forum held at San Diego City College; (3) a manufacturing technology issues forum held at Los Angeles Trade-Technical College; (4) a high technology demonstration project implemented at Los Angeles City College; and (5) the Responsive Energy Technology Symposium and International Exhibition convened in San Diego. Each review contains a summary of activities and pertinent issues, and a series of recommendations. Following a brief summary of future industries which Partnership 2000 plans to target, the dissemination of project materials and internal evaluation procedures are discussed. Appendixes provide the Partnership 2000 vision statement and a list of core advisory committee members. (JMC)

Descriptors: Articulation (Education); Aviation Education; College Planning; Community Colleges; *Cooperative Programs; Energy Education; *Government School Relationship; Health Education; *Job Training; Labor Force Development; Manufacturing; Program Implementation; *School Business Relationship; Technological Advancement; Transportation; Two Year Colleges; Vocational Education

Identifiers: California; *Partnership 2000

ED334294 UD028058

**De Anza: A Paideia School. Classical Studies Program 1990-91 Course Offerings for the Classical Studies High School.**

Richmond Unified School District, Calif.

1990

77p.

EDRS Price - MF01/PC04 Plus Postage.

Language: English

Document Type: DIRECTORY (132); PROJECT DESCRIPTION (141)

Geographic Source: U.S.; California

Journal Announcement: RIENOV91

Target Audience: Parents

The Richmond (California) Unified School District's System for Choice allows parents and students to select from a variety of programs designed to satisfy diverse interests and needs. This publication describes offerings at De Anza High School, a Paideia school. De Anza is the only high school in the district that offers Classical Studies, a challenging academic program designed to prepare every student for college and productive employment. Classical Studies incorporates the following elements: (1) computer use across the curriculum; (2) coaching; (3) seminars; (4) extra support to help students achieve, including both academic and behavioral support; and (5) common classroom practices and whole-school strategies to manage student behavior, including goal-setting and self-evaluation, clear expectations, organization, troubleshooting, and community service. The publication lists graduation requirements, state college and university entrance requirements, sample student schedules, and a summary course list. Course descriptions are provided for the following departments and areas: (1) applied academics, including business education, consumer home economics, and industrial technology; (2) bilingual education; (3) career development; (4) computer science; (5) English; (6) fine and performing arts, including art, music, and theatre; (7) foreign languages; (8) library; (9) mathematics; (10) other courses; (11) physical education; (12) science; (13) social science; and (14) special education. Each entry includes grade level, course length, prerequisites, graduation requirements, and a brief description. (AF)

Descriptors: *Academic Education; *Advanced Courses; *Articulation (Education); *College Preparation; *Comprehensive Programs; Course Descriptions; *High Schools; Honors Curriculum; Integrated Curriculum; Parent Participation ; Program Descriptions; School Choice

Identifiers: Paideia; *Richmond Unified School District CA

ED333220 CE058306

**Roanoke Area 2+2 Program in Automated Manufacturing Technology. Vocational Education Project Final Report.**

Roanoke City Public Schools, Va.

15 Nov 1990

228p.

Sponsoring Agency: Virginia State Dept. of Education, Richmond. Div. of Vocational and Adult Education.

EDRS Price - MF01/PC10 Plus Postage.

Language: English

Document Type: TEACHING GUIDE (052); PROJECT DESCRIPTION (141)

Geographic Source: U.S.; Virginia

Journal Announcement: RIENOV91

Target Audience: Teachers; Practitioners

The Roanoke Area 2+2 Project in Automated Manufacturing Technology was undertaken as a cooperative effort of area industries, government, and education to meet the needs of area industries. The program includes 2 years of technical training in high school combined with strong academic preparation and continues with 2 years of advanced technical training at the community college level. The curriculum was written by a curriculum team including representatives of all six participating school systems and Virginia Western Community College; industry representatives participated in Developing a Curriculum (DACUM) workshops to identify the duties and tasks necessary in the field of automated manufacturing. The project featured a strong public relations component because of the need to attract able students. The project was evaluated by Virginia Tech through survey forms, questionnaires, and rating sheets. Response to the project was positive and it has received several awards. The project is continuing student recruitment and expanding into other areas of automated manufacturing. (Following the first section, which is a short final report, most of this document is made up of project documents organized in six sections: project overview in the form of transparencies or handouts, DACUM/industry involvement; curriculum development, including tasks and competencies; public relations; awards and recognition; a 79-page evaluation; and five references. (KC)

Descriptors: *Articulation (Education); Competence; Competency Based Education; *Computer Assisted Manufacturing; Cooperative Programs; Course Content; *Curriculum Development Education Work Relationship; High Schools; Program Development ; Program Implementation; *School Business Relationship; Task Analysis; *Technical Education; Two Year Colleges

Identifiers: 2 Plus 2 Tech Prep Associate Degrees; DACUM Process

ED332029 CE058016

**It Works Idaho Division of Vocational-Technical Education Annual Report Fiscal Year 1990.**

Idaho State Dept. of Education, Boise. Div. of Vocational Education.

1990

47p.; Contains colored print on colored paper.

EDRS Price - MF01/PC02 Plus Postage.

Language: English

Document Type: PROJECT DESCRIPTION (141)

Geographic Source: U.S.; Idaho

Journal Announcement: RIEOCT91

Government: State

During fiscal year 1990, Idaho's vocational-technical system conducted activities toward attainment of five major goals. To promote economic progress by meeting employer needs for trained workers (goal 1) the technical system strengthened interaction between employers and educators; focused on vocational training to support industries and new economic development through the Consortium of Vocational-Technical Institutions, carried out customized training programs, industry-specific upgrade training programs, and the Workplace Literacy Project; and provided entrepreneurship training. To provide students with foundation skills required for success in technical and skilled occupations (goal 2), the system piloted applied biology/chemistry courses; restructured curricula to emphasize general preparation for employment; developed industrial technology programs; and supported vocational student organizations. To meet student needs for vocational education in selected occupations (goal 3), the system offered secondary and postsecondary programs and provided upgrade training and retraining. To ensure equal access to vocational training (goal 4), vocational equity projects and guidance and counseling projects were conducted; the Idaho Career Information System was continued; and populations with special barriers to the work force were served. To ensure greater flexibility, the system oversaw postsecondary and secondary articulation and coordinated programs and entry/reentry programs. Finally, the system attained the fifth goal, to revise the preparation and development of instructors to meet the new goals, through redesign of university-level teacher preparation programs to reflect changing requirements and provision of continuing professional development. (YLB)

Descriptors: Access to Education; Annual Reports; Articulation (Education); Basic Skills; Career Awareness; *Career Education; Educational Needs; *Educational Objectives Education Work Relationship; Entrepreneurship; *Equal Education; Postsecondary Education; Professional Development; Retraining; Secondary Education; Sex Fairness; Special Needs Students; *State Programs; Statewide Planning; Student Needs; *Teacher Education; *Vocational Education

Identifiers: *Idaho

ED330844 CE057579

**Project TECH (Technology Education Curriculum Help).**

Pecosh, Joseph

California Univ. of Pennsylvania.

30 Jun 1988

267p.

Sponsoring Agency: Pennsylvania State Dept. of Education,

(cont. next page)

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Harrisburg. Bureau of Vocational and Adult Education.
Contract No.: 85-8052
EDRS Price - MF01/PC11 Plus Postage.
Language: English
Document Type: PROJECT DESCRIPTION (141); TEST, QUESTIONNAIRE (160)
Geographic Source: U.S.; Pennsylvania
Journal Announcement: RIESEP91

California University of Pennsylvania developed Project Technology Education Curriculum Help (TECH) for two school districts in Western Pennsylvania. Six objectives were achieved: (1) organized two pilot school districts to serve as curriculum models in technology education for other schools throughout the commonwealth; (2) established California University as a resource center for the dissemination of curriculum materials in technology education to interested school districts; (3) developed a demonstration curriculum development project in two public schools; (4) modified the Industry and Technology Curriculum Plan to include competency-based education that fits the resources and needs of schools; (5) provided a vehicle for articulation efforts among secondary and postsecondary institutions providing technical education in Southwestern Pennsylvania; and (6) evaluated the success of Project TECH, its ability to provide significant resources for area schools, and its use as a model. The bulk of the document consists of six appendices as follows: (1) questionnaires and report of a survey of Southwestern Pennsylvania school districts on the status of technology education programs; (2) sample third-party articulation contracts; (3) course outlines and sample technology activities for grades seven (exploring technology), eight (applying technology), and nine (technological enterprise); (4) letters of support for continuing Project TECH; (5) Project TECH progress report for Chartiers-Houston school district (Pennsylvania); and (6) Project TECH project report for Cannon-McMillan school district (Pennsylvania). (NLA)

Descriptors: *Articulation (Education); Competency Based Education; *Curriculum Development; *Demonstration Programs; Information Dissemination; Junior High Schools; Postsecondary Education; Program Effectiveness; *Technology
Identifiers: *Pennsylvania; *Technology Education

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ED330839 CE057552
**Development of Articulated Competency-Based Curriculum in Computer Assisted/Computer Integrated Manufacturing Technology. Final Report.**
Luzerne County Community Coll., Nanticoke, Pa.
30 Sep 1988
180p.; For an earlier report, see ED 288 019.
Sponsoring Agency: Pennsylvania State Dept. of Education, Harrisburg. Bureau of Vocational and Adult Education.
Contract No.: 85-8025
EDRS Price - MF01/PC08 Plus Postage.
Language: English
Documunt Type: TEACHING GUIDE (052)
Geographic Source: U.S.; Pennsylvania
Journal Announcement: RIESEP91
Target Audience: Teachers; Practitioners

The project described in this report was conducted at the Community College of Luzerne County (Pennsylvania) to develop, in conjunction with area vocational-technical schools, the second year of a competency-based curriculum in computer-integrated manufacturing (CIM). During the project, a task force of teachers from the area schools and the college developed courses and competencies for both secondary and postsecondary CIM programs. The task force also developed materials and equipment lists, supervised the layout of the CIM laboratory in a new Advanced Technology Center, created a competency-based catalog of proposed courses, and implemented the program. Most of this document consists of the curriculum materials, including competencies for 10 CIM courses, recommendations for equipment/software selection, and recommendations for articulation. Attachments include a list of task force members, task force data and recommendations, the Advanced Technology Center brochure, a program brochure, and specifications for seven pieces of equipment. (KC)

Descriptors: *Articulation (Education); Community Colleges; *Competency Based Education; *Computer Assisted Manufacturing Computer Software; Course Content; *Curriculum Development; Equipment; Regional Schools; Secondary Education; Two Year Colleges; *Vocational Schools
Identifiers: *Computer Integrated Manufacturing; Luzerne County Community College PA

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ED307955 JC890319
**Focus on Student Achievement: School and College Partnership.**
Beckley, Larry; And Others
Jun 1989
10p.; Paper presented at the League for Innovation in the Community College Conference, "Leadership 2000" (San Francisco, CA, June 11-14, 1989).
EDRS Price - MF01/PC01 Plus Postage.
Language: English
Document Type: PROJECT DESCRIPTION (141); CONFERENCE PAPER (150)
Geographic Source: U.S.; Illinois
Journal Announcement: RIENOV89
Target Audience: Practitioners

Recognizing the importance of strong working relationships with local high schools, Triton College (Illinois) has recently developed a series of initiatives which provide an ongoing avenue for students to experience Triton's programs and services while still in high school and thereby facilitate continuity of learning. One group of programs, focusing primarily on dropout prevention and intervention, includes: (1) the High School/College Partnership, which provides summer enrichment programs, after-school and summer jobs, tutoring, career exploration, recognition awards, and a tracking system

(cont. next page)

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for high-risk youth; (2) opportunities for dropouts to complete high school course work at Triton through the Alternative High School, Evening High School, and Adult High School; and (3) a cooperative English-as-a-Second Language-Program. A second set of programs focuses on serving gifted and talented students. Triton's Scholars Program, which is designed as a "college within a college," offers courses modeled on those of prestigious colleges and universities, heavily utilizes guest lecturers, and provides scholarships. In addition, academically talented students who qualify for advanced placement have the opportunity to take several courses for college credit in their senior year. A third project is the Student Post-Secondary Plan, which seeks to make the 13th year of schooling as routine as the previous 12 through a rigorous program of assessment and counseling. Triton's most recent initiative is the Regional Vocational Articulation Project. In fall 1989, 12 articulated 2 + 2/prep-tech programs will be in place in business, industrial technology, and home economics. (JMC)

Descriptors: *Academically Gifted; Advanced Placement Programs; *Articulation (Education); College Preparation; *College School Cooperation; Community Colleges; Counseling Services; *Dropout Prevention; Dropout Programs; *Educational Counseling; High Risk Students; Honors Curriculum; Two Year Colleges; Vocational Education

Identifiers: *Triton College IL

EJ434086 CE523095
**Perceptions of Quality in Industrial Technology Programs.**
Brown, Ryan K.
Journal of Epsilon Pi Tau; v17 n1 p4-17 Win-Spr 1991
ISSN: 0001-0898
Available from: UMI
Language: English
Document Type: JOURNAL ARTICLE (080); RESEARCH REPORT (143)
Journal Announcement: CIJMAR92

Responses from 298 students, 119 institutions, 369 faculty, and 85 businesses identified the following characteristics of quality in industrial technology programs: (1) reputable relationship with industry; (2) effective teachers; (3) state-of-the-art facilities; and (4) opportunities for cooperative education, internships, or professional practice. (JOW)

Descriptors: •Educational Quality; Higher Education; •Industry; •Program Effectiveness; Program Evaluation; •School Business Relationship; Tables (Data); •Technology; Vocational Schools

EJ432168 CE522955
**Making the Curriculum Transition from Industrial Arts to Technology Education.**
Kuskie, Larry
Technology Teacher; v51 n1 p32-35 Sep-Oct 1991
ISSN: 0746-3537
Available from: UMI
Language: English
Document Type: JOURNAL ARTICLE (080); POSITION PAPER (120)
Journal Announcement: CIJFEB92

Presents a conceptual approach to changing curriculum from industrial arts to technology education. Discusses the need for philosophical and objective development on the part of teachers. Describes how curriculum needs to evolve, facilities must be designed, and the whole implementation process must be evaluated. (JOW)

Descriptors: •Curriculum Development; Educational Facilities Design; Educational Objectives; •Educational Philosophy; •Industrial Arts; Program Evaluation; Program Implementation; Secondary Education
Identifiers: •Technology Education

EJ365137 JC504649
**A New Partnership for Today's Technology Programs.**
Kerekgyarto, George A.
Community Services Catalyst; v18 n1 p17-19 Win 1988
Available from: UMI
Language: English
Document Type: JOURNAL ARTICLE (080); PROJECT DESCRIPTION (141)
Journal Announcement: CIJMAY88

Examines the articulation of an industrial technology teacher education program between a university and a community college for the purpose of delivering a technology-based education program at the university. Outlines program needs that led to the articulation effort, factors associated with successful articulation, problems that developed, and logistical considerations. (DMM)

Descriptors: •Articulation (Education); Community Colleges; Higher Education; Industry; •Intercollegiate Cooperation; Program Descriptions; •Program Development; State Universities ; •Teacher Education; •Technical Education; Technology; Two Year Colleges; •Vocational Education Teachers

EJ342181 CE517319
**Characteristics of a Model Industrial Technology Education Field Experience.**
Foster, Phillip R.; Kozak, Michael R.
Technology Teacher; v46 n2 p23-26 Nov 1986
Available from: UMI
Language: English
Document Type: JOURNAL ARTICLE (080); RESEARCH REPORT (143)
Journal Announcement: CIJFEB87

This report contains selected findings from a research project that investigated field experiences in industrial technology education. Funded by the Texas Education Agency, the project addressed the identification of characteristics of a model field experience in industrial technology education. This was accomplished using the Delphi technique. (Author/CT)

Descriptors: •Delphi Technique; •Field Experience Programs; •Industrial Education; Postsecondary Education; •Program Design; Program Evaluation; •Student Teachers; Teacher Education; •Technology

EJ335026 SE539140
**Training a New Breed of Automated Manufacturing Technology Practitioners.**
Bainter, Jack J.
Technological Horizons in Education; v13 n7 p81-85 Mar 1986
Available from: UMI
Language: English
Document Type: JOURNAL ARTICLE (080); PROJECT DESCRIPTION (141)
Journal Announcement: CIJAUG86
Target Audience: Practitioners

A boom in industrial robotics has led numerous vocational institutions to launch extensive training programs in this specialty. ITT Educational Services offers two curriculum programs to train future manufacturing engineers. The firm's national director describes this model curriculum for meeting the needs of today's workforce. (JN)

Descriptors: •Computer Oriented Programs; Electronics; Engineering; •Engineering Education; Higher Education; •Manufacturing; •Manufacturing Industry; •Program Descriptions ; •Robotics; Training
Identifiers: Electrical Engineering

EJ320637 CE515797

**Industrial Technology Education: A Flexible Program.**

Umstattd, William D.

Journal of Industrial Teacher Education; v22 n4 p13-22 Sum 1985

Available from: UMI

Language: English

Document Type: JOURNAL ARTICLE (080); RESEARCH REPORT (143)

Journal Announcement: CIJNOV85

This article reports a survey of Bachelor of Science in Education Degree graduates in industrial technology education from The Ohio State University. The program is described first. Then responses of former students are presented and analyzed. (Author/CT)

Descriptors: *Bachelors Degrees; *Education Majors; Higher Education; *Industry; *Program Descriptions; Program Evaluation; Program Improvement; Student Attitudes; Surveys; Teacher Attitudes; *Teacher Education; *Technology

Identifiers: *Ohio State University

EJ314426 SE537070

**On-Campus Projects: Inventing a Microchip.**

Basta, Nicholas

Graduating Engineer; (Women's Issue) p98-101 Feb 1985

Available at no charge to senior engineering students, deans, engineering department heads, and placement directors at engineering colleges from McGraw-Hill, Inc., 1221 Ave. of the Americas, New York, NY 10020 (single copies $5.00).

Language: English

Document Type: JOURNAL ARTICLE (080); PROJECT DESCRIPTION (141)

Journal Announcement: CIJJUN85

Target Audience: Practitioners

In response to growth of microelectronics and changes in microchip design/manufacturing technology, universities are supporting class projects for students. Approximately 50 schools now conduct such programs which have resulted from earlier National Science Foundation sponsorship. Major advantages for the students include designing experience, cooperation with peers, and competition between groups. (DH)

Descriptors: College Instruction; Course Descriptions; *Engineering; *Engineering Education; Engineers; Higher Education; *Program Descriptions; *Student Projects; Universities

Identifiers: *Microchips; *Microelectronics

EJ233624 CE510099

**Some Characteristics of Master's Degree Programs in Industrial Technology.**

James, William E.; Johnson, Robert R.

Journal of Industrial Teacher Education; v17 n4 p4-10 Sum 1980

Available from: Reprint: UMI

Language: English

Document Type: JOURNAL ARTICLE (080); RESEARCH REPORT (143)

Journal Announcement: CIJMAR81

In a study of master's degree programs in industrial technology, it was concluded that, in general, the programs are not research oriented and demonstration of research competency, beyond satisfactorily completing a research methods course, is not a major requirement. A more comprehensive monitoring of these programs is recommended. (CT)

Descriptors: Graduate Study; *Graduation Requirements; *Industry; *Masters Programs; Masters Theses; Postsecondary Education; Program Evaluation; *Research; Student Research; *Technical Education; *Technology

ED336636 CE059130

**Technology Education in Action: Outstanding Programs.**

International Technology Education Association, Reston, VA.

1989

64p.

Available from: International Technology Education Association, 1914 Association Drive, Reston, VA 22091-1502 ($8.00 members; $10.00 nonmembers).

EDRS Price - MF01/PC03 Plus Postage.

Language: English

Document Type: PROJECT DESCRIPTION (141)

Geographic Source: U.S.; Virginia

Journal Announcement: RIEFEB92

Target Audience: Teachers; Practitioners

This volume contains 10 articles describing middle school and high school technology education programs conducted in schools throughout the United States. Program descriptions, which are written by the teachers involved in the programs, are from schools in the following areas: Ann Arbor, Michigan; Chicago, Illinois; Pittsburg, Kansas; Salt Lake City, Utah; Shaker Heights, Ohio; Bellevue, Washington; Charles County, Maryland; Greece, New York; Troy, Illinois; and Conroe, Texas. Each program described involves hands-on uses of technology and features problem solving by students. Programs also stress curriculum integration with mathematics, science, and communication areas. Photos are included with the descriptions. (KC)

Descriptors: Classroom Techniques; Course Content; *Demonstration Programs; Educational Improvement; *Educational Innovation; Educational Resources; High Schools; *Integrated Curriculum; Intermediate Grades; Junior High Schools; Laboratories; Middle Schools; Program Descriptions; Science Education; Teacher Developed Materials; Teaching Methods; *Technological Literacy; *Technology

Identifiers: Ann Arbor Public Schools MI; Charles County Public Schools MD; Chicago Public Schools IL; Conroe Independent School District TX; Granite School District VT; Pittsburg Unified School District KS; *Technology Education; University School Shaker Heights OH

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ED336519 CE058858
**Missouri Industrial Technology/Technology Education Guide.**
Missouri State Dept. of Elementary and Secondary Education, Jefferson City. Div. of Vocational and Adult Education.
1991
578p.
Available from: Instructional Materials Laboratory, University of Missouri, 2316 Industrial Drive, Columbia, MO 65202 (order no. 60-0286-I: $35.80).
EDRS Price - MF03 Plus Postage. PC Not Available from EDRS.
Language: English
Document Type: TEACHING GUIDE (052)
Geographic Source: U.S.; Missouri
Journal Announcement: RIEFEB92
Target Audience: Teachers; Practitioners

This guide is Missouri's primary resource for planning, implementing, and evaluating Industrial Technology/Technology Education (ITE/TE). It contains 10 chapters: (1) a direction for ITE/TE; (2) planning the ITE/TE program; (3) planning ITE/TE facilities; (4) implementing a safety program; (5) creating ITE/TE's image (public relations); (6) teaching ITE/TE; (7) organizing and managing the ITE/TE program; (8) evaluating ITE/TE; (9) meeting professional responsibilities; and (10) helpful resources. A list of 138 figures and 3 tables is included. Chapter 10 contains an index of forms, an index of 72 Technology Activity Modules, and recommended ITE/TE competencies and articulation links depicted in graphic form. (NLA)

Descriptors: Articulation (Education); Competency Based Education; *Curriculum Development; Educational Facilities Planning; Employment Potential; High Schools; *Industry; Inservice Teacher Education; Job Skills; *Program Administration; Program Development; Program Evaluation; Public Relations; School Safety; Student Evaluation; Teaching Guides; *Technology
Identifiers: *Missouri; *Technology Education

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ED334294 UD028058
**De Anza: A Paideia School. Classical Studies Program 1990-91 Course Offerings for the Classical Studies High School.**
Richmond Unified School District, Calif.
1990
77p.
EDRS Price - MF01/PC04 Plus Postage.
Language: English
Document Type: DIRECTORY (132); PROJECT DESCRIPTION (141)
Geographic Source: U.S.; California
Journal Announcement: RIENOV91
Target Audience: Parents

The Richmond (California) Unified School District's System for Choice allows parents and students to select from a variety of programs designed to satisfy diverse interests and needs. This publication describes offerings at De Anza High School, a Paideia school. De Anza is the only high school in the district that offers Classical Studies, a challenging academic program designed to prepare every student for college and productive employment. Classical Studies incorporates the following elements: (1) computer use across the curriculum; (2) coaching; (3) seminars; (4) extra support to help students achieve, including both academic and behavioral support; and (5) common classroom practices and whole-school strategies to manage student behavior, including goal-setting and self-evaluation, clear expectations, organization, troubleshooting, and community service. The publication lists graduation requirements, state college and university entrance requirements, sample student schedules, and a summary course list. Course descriptions are provided for the following departments and areas: (1) applied academics, including business education, consumer home economics, and industrial technology; (2) bilingual education; (3) career development; (4) computer science; (5) English; (6) fine and performing arts, including art, music, and theatre; (7) foreign languages; (8) library; (9) mathematics; (10) other courses; (11) physical education; (12) science; (13) social science; and (14) special education. Each entry includes grade level, course length, prerequisites, graduation requirements, and a brief description. (AF)

Descriptors: *Academic Education; *Advanced Courses; *Articulation (Education); *College Preparation; *Comprehensive Programs; Course Descriptions; *High Schools; Honors Curriculum; Integrated Curriculum; Parent Participation ; Program Descriptions; School Choice
Identifiers: Paideia; *Richmond Unified School District CA

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ED332770 JC910296
**Community College Exemplary Instructional Programs, Volume III.**
Fideler, Elizabeth F., Ed.; Bazer, Gerald, Ed.
American Association of Community and Junior Colleges, Washington, DC. National Council of Instructional Administrators.
1990
219p.
Available from: Massachusetts Bay Community College Press, 50 Oakland Street, Wellesley Hills, MA 02181 ($12.00).
EDRS Price - MF01 Plus Postage. PC Not Available from EDRS.
Language: English
Document Type: DIRECTORY (132); PROJECT DESCRIPTION (141)
Geographic Source: U.S.; Massachusetts
Journal Announcement: RIEOCT91
Target Audience: Practitioners

Third in an annual series, this volume presents brief descriptions of a number of outstanding community college instructional programs identified by the National Council of Instructional Administrators (NCIA). Each description includes the address and telephone number of the college in which the program operates, and the names of the college president and a contact person. Section I provides a complete program description of the recipient of the 1989-90 Annual NCIA Exemplary Instructional Program Award, that is, the Chemical

(cont. next page)

Dependency Program at Rio Salado Community College (Arizona). Section II contains shorter descriptions of the seven programs which received honorable mention in the NCIA competition. They are Apprentice Training at Community College of Rhode Island; Automated Furniture Manufacturing Technology at Itawamba Community College (Mississippi); Environmental Control/Hazardous Waste at Ulster County Community College (New York); Horse Training and Management at Lamar Community College (Colorado); Interpreter Training Program at Front Range Community College (Colorado); Nuclear Engineering Technology at Thames Valley State Technical College (Connecticut); and Swine Management at John Wood Community College (Illinois). Section III presents descriptions of over 200 institutional entries for the NCIA award, listed alphabetically under the following categories: Allied Health; Arts and Sciences; Business; Honors; Hospitality; Instructional Approaches; Nursing; and Technical. Letters from previous Exemplary Instructional Program Award winners, an index of participating colleges and a NCIA membership application conclude the volume. (JMC)

Descriptors: *Awards; *Community Colleges; *Demonstration Programs; *Instructional Innovation; *Program Content; Program Descriptions; *Program Design; Program Evaluation; Two Year Colleges

ED327735 CE056832

**Materials Technology: The Common Core Skills That Are Shaping the Future. Final Performance Report. January 1, 1989-June 30, 1990.**

Battelle Pacific Northwest Laboratories, Richland, Wash.; Central Washington Univ., Ellensburg.; Northwest Regional Educational Lab., Portland, Oreg.; Richland School District 400, Wash.

Sep 1990

56p.; For a related document, see CE 056 831. Includes "Materials Science and Technology: External Evaluation Report," by Northwest Regional Educational Laboratory.

Sponsoring Agency: Office of Vocational and Adult Education (ED), Washington, DC.

Contract No.: V199A90105

EDRS Price - MF01/PC03 Plus Postage.

Language: English

Document Type: EVALUATIVE REPORT (142)

Geographic Source: U.S.; Washington

Journal Announcement: RIEJUN91

A materials technology program was developed at Richland High School (Washington) and pilot tested at seven sites in Washington and Oregon. The program created partnerships between science and vocational education teachers at Richland High and Battelle Pacific Northwest Laboratories, and was then expanded to include other high schools, colleges, and other industrial laboratories. During the initial program, a steering committee was organized, a literature search was conducted, a curriculum was developed and validated, teachers were trained, and pilot sites were selected. More than 225 students were enrolled in the program. Teachers were selected and trained in workshops and through industry programs. An evaluation by Northwest Regional Educational Laboratory showed that the teacher training workshop and the program both received a majority of excellent or good ratings from teachers and/or students in all categories evaluated. The curriculum and project descriptions were disseminated through educators' and researchers' meetings and workshops. (KC)

Descriptors: Ceramics; Cooperative Programs; *Curriculum Development; Education Work Relationship; Glass; *Industry; *Integrated Curriculum; Metals; Pilot Projects; Polymers; Postsecondary Education; Program Evaluation; *School Business Relationship; Science Education; Secondary Education; Technical Occupations; Technological Advancement; *Technology Vocational Education

Identifiers: *Materials Technology; Partnerships in Education; Technology Education

ED294012 CE050039

**The Key Technologies. Some Implications for Education and Training. An Occasional Paper.**

Mansell, Jack; And Others

Engineering Council, London (England).; Further Education Unit, London (England).

Feb 1988

35p.

Report No.: ISBN-1-85338-045-8

EDRS Price - MF01/PC02 Plus Postage.

Language: English

Document Type: POSITION PAPER (120)

Geographic Source: United Kingdom; England

Journal Announcement: RIEOCT88

National competitiveness depends in large part on the practical application of technologies. Educational planners must, therefore, identify key (newly emerging) topics in science and engineering that are likely to have a major evolutionary effect on industry and incorporate these areas into existing vocational and technical curricula. Because industry adopts new techniques faster than the education system, educational institutions working to prepare students for an uncertain future must teach them fundamental principles, including design, that underpin the development of specialist expertise as well as economic awareness and associated management and business skills. A regular review of technology-based curricula is necessary to ensure that course content and teaching methods are up to date. Each educational institution should, in consultation with its industrial and commercial partners, identify which changing technologies should be incorporated into vocational curricula. Emphasis should be placed on practical examples and on the development of economic awareness in all areas of the curriculum. The key technologies concept is intended to call attention to attitudes toward technology rather than to provide a shopping list" of new technologies. (Appendixes contain discussions of the United Kingdom's import problem, the problem-solving approach, and robotics and advanced manufacturing technology

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as a practical example of the teaching of a key technology. (MN)

Descriptors: •Curriculum Development; •Educational Change; •Emerging Occupations; Foreign Countries; Postsecondary Education; •Program Evaluation; Program Improvement; Secondary Education; •Technological Advancement; •Vocational Education

Identifiers: •United Kingdom

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ED288995 CE048662

**Missouri Industrial Technology Education Guide.**

Missouri Univ., Columbia. Dept. of Practical Arts and Vocational-Technical Education.

1987

320p.

Sponsoring Agency: Missouri State Dept. of Elementary and Secondary Education, Jefferson City. Div. of Vocational and Adult Education.

Available from: Instructional Materials Laboratory, 908 Woodson Way, University of Missouri-Columbia, Columbia, MO 65211.

EDRS Price - MF01/PC13 Plus Postage.

Language: English

Document Type: NON-CLASSROOM MATERIAL (055)

Geographic Source: U.S.; Missouri

Journal Announcement: RIEMAY88

Target Audience: Teachers; Practitioners

This guide is intended to serve as Missouri's primary resource for planning, implementing, and evaluating industrial technology/industrial arts education. The following topics are covered: selecting a direction for industrial technology education (ITE) (its underlying philosophy, mission, goals); planning an ITE program (recommended scope and sequence for ITE, recommended courses for ITE, revision or updating of existing programs, steps in starting a new program, procedures for documenting the curriculum); implementing an ITE program (following current trends in ITE, updating existing facilities, planning new facilities, equipping an ITE program, maintaining laboratory equipment, implementing a safety program, informing key constituents); teaching ITE (planning instruction, selecting instructional materials, meeting individual and special needs, providing for equity, incorporating student organization activities, teaching employability skills); organizing and managing an ITE program (gaining access to key resource personnel, using advisory committees, organizing and managing ITE), evaluating ITE (evaluating program, student, and teacher performance); meeting professional responsibilities (ethics, pre- and inservice education, professional involvement); and using resources (the Missouri Industrial Technology Education Standards, the Missouri ITE Guide, recommended competencies for core courses). (MN)

Descriptors: Classroom Techniques; Ethics; •Industrial Arts •Industrial Education; Industry; Professional Development; Program Administration; •Program Development; Program Evaluation; Program Guides; •Program Implementation; Records (Forms); Secondary Education; State Standards; •Statewide Planning; Student Evaluation; Student Organizations; Teacher Certification; Teacher Evaluation; •Teacher Improvement; Teacher Responsibility; Teaching Methods; Technical Education Technological Literacy; Technology

Identifiers: •Missouri

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ED268345 CE044256

**Industrial Arts Education. Teacher Handbook. Vocational Education. Grades 9-12. North Carolina Competency-Based Curriculum.**

North Carolina State Dept. of Public Instruction, Raleigh. Div. of Vocational Education.

1985

339p.; For related documents, see CE 044 254-261.

EDRS Price - MF01/PC14 Plus Postage.

Language: English

Document Type: TEACHING GUIDE (052)

Geographic Source: U.S.; North Carolina

Journal Announcement: RIESEP86

Government: State

Target Audience: Teachers; Practitioners

This teacher handbook provides recommended goals and objectives and suggested measures for competency-based courses in the vocational program area of industrial arts. A background and overview section contains the philosophy and rationale, discusses thinking skills and programs for exceptional children, and provides notes that explain how to read the goals, objectives, and measures and offer suggestions for student placement, textbook use, and activities. This specific information is then provided for a vocational education competency-based curriculum: purpose and overview (target groups, philosophy, curriculum planning and design) and course of study. For industrial arts, grades 9-12, are offered a program description, learning outcomes, and scope and sequence. These courses are included in the curriculum: architectural drawing and planning, basic electricity/electronics technology, communications technology, construction technology, contemporary technology, energy/power and transportation, exploring technology, graphic arts technology, manufacturing technology, materials and processing, metals technology, plastics technology, technical drawing and planning, and wood technology. Materials provided for each course include a topical outline and a one-page format for each competency goal that details grade level, skills/subject area, the competency goal, objective(s), and measure(s) (suggestions of ways in which students may demonstrate their ability to meet the objective). (YLB)

Descriptors: Architectural Drafting; Behavioral Objectives; Building Plans; Career Exploration; •Communications; •Competency Based Education; Construction (Process); Course Descriptions; Electricity; •Electronics; Energy; Engineering Drawing; Evaluation Criteria; •Graphic Arts; •Industrial Arts •Manufacturing; Metal Industry; Metals; Plastics; Power Technology; Program Descriptions; Secondary Education; Student

(cont. next page)

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Evaluation; Technology; Transportation; Vocational Education; Woodworking

Identifiers: •Materials Processing

ED266256 CE043499

**Guidebook for Industrial Technology Teacher Preparation Field Experience.**

Foster, Phillip R.; And Others

North Texas State Univ., Denton. Div. of Industrial Technology.

30 Jun 1985

93p.; A product of the Assessment of Industrial Arts Field Experiences. For the final research report of this project, see CE 043 498.

Sponsoring Agency: Texas Education Agency, Austin. Dept. of Occupational Education and Technology.

EDRS Price - MF01 Plus Postage. PC Not Available from EDRS.

Language: English

Document Type: NON-CLASSROOM MATERIAL (055); TEST, QUESTIONNAIRE (160)

Geographic Source: U.S.; Texas

Journal Announcement: RIEJUL86

Target Audience: Teachers; Practitioners

This handbook is intended to assist in the assessment and refinement of teacher preparation for industrial technology education in Texas. The first section contains preliminary information on the significance, development, and use of the guidebook. Provided next is an industrial technology teacher preparation assessment instrument that is based on a national survey of model or exemplary industrial technology teacher preparation programs. The next section contains a second industrial teacher preparation assessment instrument, which was developed for a three-round Delphi study. The fourth and final section consists of suggested recommendations for program improvement that were written with the following considerations in mind: essential elements, special needs students, equal access, and appropriate computer applications. Extensive appendixes include an instrument for assessing model field experience programs, survey results of model industrial technology field experience programs, statements characterizing a model industrial technology field experience, essential elements for introductory industrial technology courses at different levels, and membership lists of various panels and committees connected with developing the materials and methods used in the guidebook. (MN)

Descriptors: Curriculum Development; Educational Needs; Evaluation Criteria; Evaluation Methods; •Field Experience Programs; Higher Education; Industrial Arts; •Industry; Needs Assessment; •Preservice Teacher Education; Program Evaluation Program Improvement; Questionnaires; •Statewide Planning; Technological Literacy; •Technology; Vocational Education; •Vocational Education Teachers

Identifiers: •Texas

ED266255 CE043498

**Assessment of Industrial Arts Field Experiences. Final Report.**

Foster, Phillip R.; And Others

North Texas State Univ., Denton. Div. of Industrial Technology.

30 Jun 1985

124p.; For the guidebook developed by this project, see CE 043 499.

Sponsoring Agency: Texas Education Agency, Austin. Dept. of Occupational Education and Technology.

EDRS Price - MF01 Plus Postage. PC Not Available from EDRS.

Language: English

Document Type: RESEARCH REPORT (143); TEST, QUESTIONNAIRE (160)

Geographic Source: U.S.; Texas

Journal Announcement: RIEJUL86

A project was conducted to assess and improve existing field experiences to prepare future industrial arts teachers in Texas. The following activities were accomplished during the project: determination of current field experiences available to industrial arts preparation students in Texas schools; identification of model industrial arts teacher preparation and materials in other states; identification, through a modified Delphi technique, of field experience elements as recommended by teacher educators and industrial arts classroom teachers; and development of a guidebook for use in implementing model field experiences in industrial arts teacher preparation programs. Information from the research conducted during the project was incorporated into a set of recommendations for improving the following aspects of industrial arts teacher education in the State: academic requirements, student teaching assignments, supervising teachers, university curricula, university supervisors, classroom supervising teachers, student teachers, and the public school environment. (Appendixes, which make up the greater part of this report, include a master list of teacher evaluation indicators, three drafts of the instrument used to assess model industrial technology field experience programs, lists of the 15 Texas schools with industrial technology teacher preparation programs and model programs identified through the nation, various project related correspondence, the three rounds of Delphi questionnaires, and quarterly project reports.) (MN)

Descriptors: Comparative Analysis; •Curriculum Development; Educational Assessment; Educational Needs; Evaluation Criteria ; Evaluation Methods; •Field Experience Programs; Higher Education; •Industrial Arts; Material Development; Models; Needs Assessment; •Preservice Teacher Education; Program Content; Program Evaluation; Questionnaires; State Surveys; •Statewide Planning; Vocational Education; •Vocational Education Teachers

Identifiers: •Texas

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